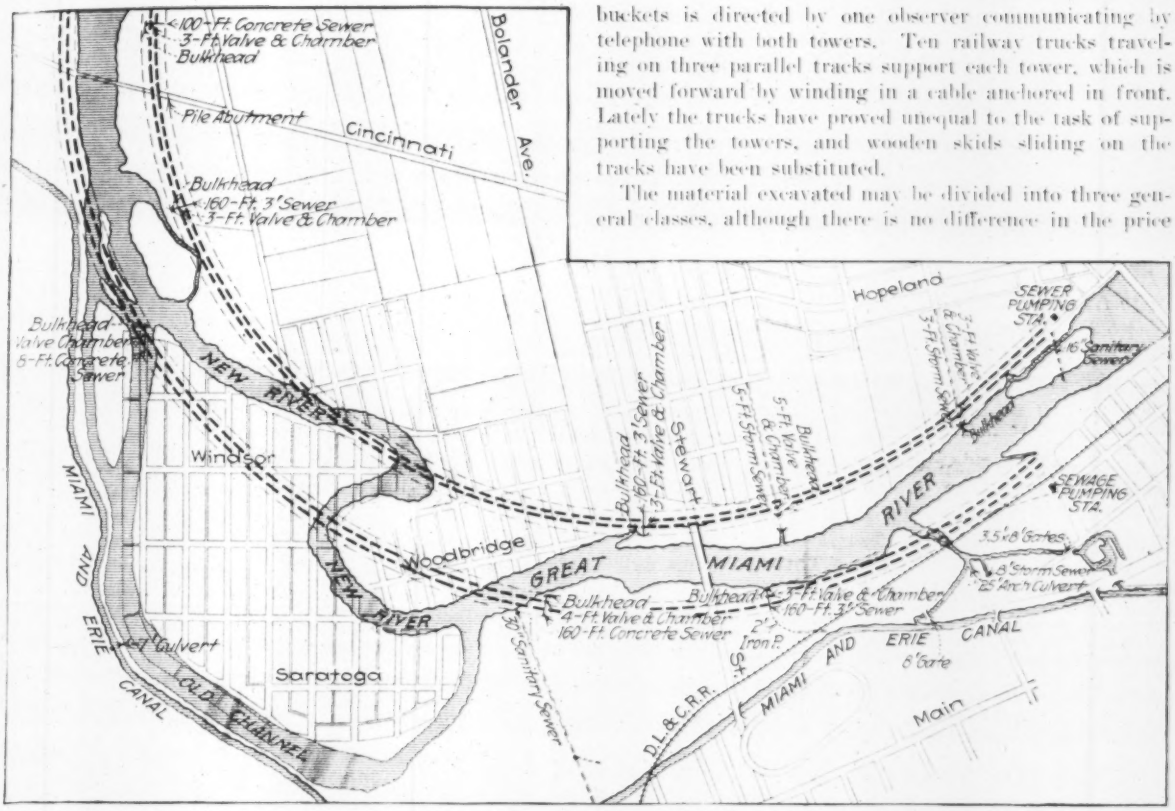


FIG. 3. PLAN OF GREAT MIAMI RIVER IMPROVEMENT UNDER WAY BY THE CITY OF DAYTON, OHIO, AT A COST OF $450,000

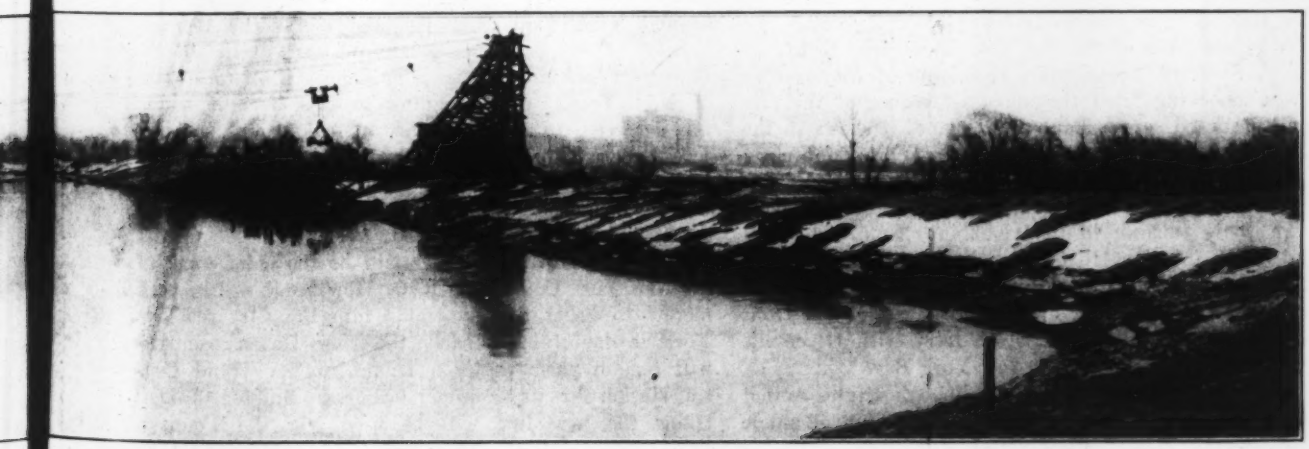
incorporated in the scheme of flood control, after a complete survey of conditions throughout the valley.

Two general methods are employed by the contractors in excavating the channel and building the levees. Wherever possible, the work is done by steam shovel and wagons; but where water is encountered, buckets running on cables stretched across the river are used. The buckets are of the Hayward 2-yd. clam-shell type, controlled by the Lambert system of hoists (see illustration).

The cables are supported by heavy wooden towers on each side of the river. Each tower contains an engine which controls one bucket, and the operation of both buckets is directed by one observer communicating by telephone with both towers. Ten railway trucks traveling on three parallel tracks support each tower, which is moved forward by winding in a cable anchored in front. Lately the trucks have proved unequal to the task of supporting the towers, and wooden skids sliding on the tracks have been substituted.

The material excavated may be divided into three general classes, although there is no difference in the price per yard. On the surface is usually found the river deposit of silt, below this a layer of sand and gravel, and beneath the gravel a deposit of lime conglomerate is sometimes encountered. This last, although troublesome, can ordinarily be broken up and removed by the buckets.

As has been stated, construction work began Sept. 1, 1914. However, on Mar. 25, 1913, the first day of the Dayton flood, the towers were up and everything was in readiness for beginning. After the waters receded, the towers were found still standing, but things were in such shape that neither the city nor the contractors were able to take up the work until eighteen months later.



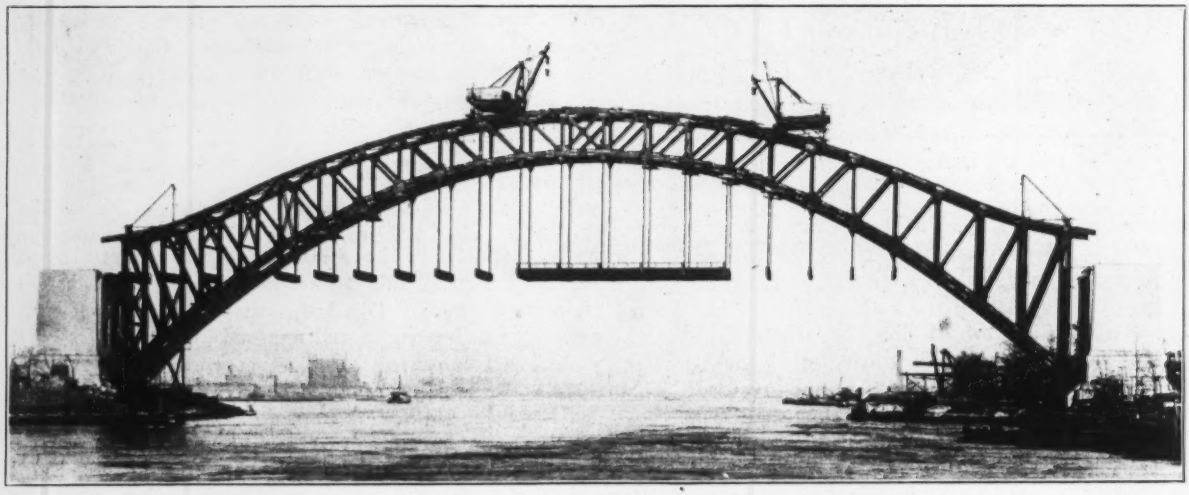
CABLEWAYS; EACH TOWER CONTAINS AN ENGINE WHICH CONTROLS A 2-CU.YD. BUCKET

First All-Rail Through Route Across New York City

[With Inset Sheet]

SYNOPSIS—Origin and history of the New York Connecting R.R., which establishes the first through railway connection across New York City. It also creates a second entrance to the heart of the city from north and east, the only prior one having been controlled by the New York Central since the early days of railways. The new line is enormously costly and includes great engineering works, chief among them the Hell Gate arch.

Well-planned strategy and 30 million dollars, embodied in a railway enterprise of remarkable simplicity and boldness, will in a few months convert New York from a city of terminals to a way-station in the east-coast railway system of the United States. Through trains will run from Boston to Philadelphia—or they may run from Portland to Jacksonville—across Manhattan Island and its two lines of defense, the East River and the Hudson.



HELL GATE BRIDGE ACROSS THE EAST RIVER AT THE BEGINNING OF 1916

The New York Connecting R.R., which will accomplish this revolutionary change, is nearing completion.

A general view of the new line, drawn true to life by E. W. Spofford, accompanies this issue of *Engineering News*. Looking from the northeast corner of the city southwestward across Manhattan Island, it shows in the foreground the main trunk of the New York Connecting R.R. and—at the left border, where the railroad forks into separate freight and passenger lines—the passenger-train route turning to the right into Sunnyside yard and on to the East River tunnels of the Pennsylvania R.R. The freight line, leading off eastward, encircles Brooklyn and in the far distance reaches the waterfront at Bay Ridge, to connect by car-ferry with Greenville on the New Jersey shore of New York Bay.

How great an achievement this line constitutes cannot be realized fully without recalling that for 80 yr. a single interest—the New York Central R.R.—has controlled entrance into New York from the north and the east. Its freight line along the west side of Manhattan Island and its passenger line leading down Fourth Ave. to the Grand Central Terminal effectively barred the way of any other railway that might seek to get into the city from New York State or New England. The New York, New Haven & Hartford R.R. therefore is a tenant in the Grand Central Terminal and brings its freight trains to Port Morris, whence a 15-mi. car-ferry trip is required to reach the New Jersey shore.

Now joining hands with the Pennsylvania, the New Haven outflanks the New York Central and by way of the new bridge-and-tunnel route not only reaches the heart of the city but continues with direct track connection to the west and the south. Instead of crossing over to Manhattan at the Harlem River frontier, the point of easiest attack, this flanking line takes the bold and difficult route via the East River islands and the Long Island shore.

The preëminent distinction of the new line is not so much its entrance into New York as its creation of a through route from New England across the Hudson barrier. Every passenger heretofore has felt the inconvenience of making the transfer from station to station in New York. Corresponding to this, freight traffic was subjected to a large surtax in making the transfer across the gap between the Bronx and the New Jersey yards, or the reverse. The inconvenience for the passenger will now be removed, and the added cost for freight transfer will be greatly reduced.

This through-traffic service will be the chief work of the New York Connecting R.R. How far it will be used merely to bring railway traffic into the City of New York is doubtful; probably the New Haven company will remain permanently a tenant in the Grand Central station for its passenger business. But for through trains the new line will be used, via the Pennsylvania station. Similarly in the matter of freight traffic: The existing yard and handling facilities will doubt-

less continue to take care of the terminal business, and the work of the new railway will be to handle the through business.

While the plan of operation has not been divulged by the railway men concerned, the fact is well established that the line will carry freight traffic chiefly. For each passenger train which the railway will take across the East and the Hudson rivers, probably a dozen freight trains will go to or from the Bay Ridge yard.

Not only the Pennsylvania R.R., but also the Lehigh Valley, the Central of New Jersey and other railways terminating on the west side of the Hudson will exchange their freight with the New Haven and its New England connections over this route. The freight traffic, in fact, is what will pay the interest on the many million dollars of bonds issued to build the line.

An Enterprise of Enormous Cost

As a problem of design and construction, the New York Connecting R.R. can hardly be compared with other railways. It stands by itself. Its key structure is a bridge of unprecedented proportions—a four-track steel arch nearly a thousand feet in span, crossing the dangerous tidal channel of Hell Gate. There are four or five other bridges of notable character, and fully four miles of viaduct, heavy and monumental.

That this construction is costly work needs no remark. The four-mile section which is now nearly ready to carry traffic has cost roughly 15 million dollars—practically 4 millions per mile. These figures represent the top notch in cost of transportation lines. What hitherto has been considered the most expensive type of railway in existence, the rapid-transit subway in a congested city district, is cheaper by one-third than the new Connecting railroad.

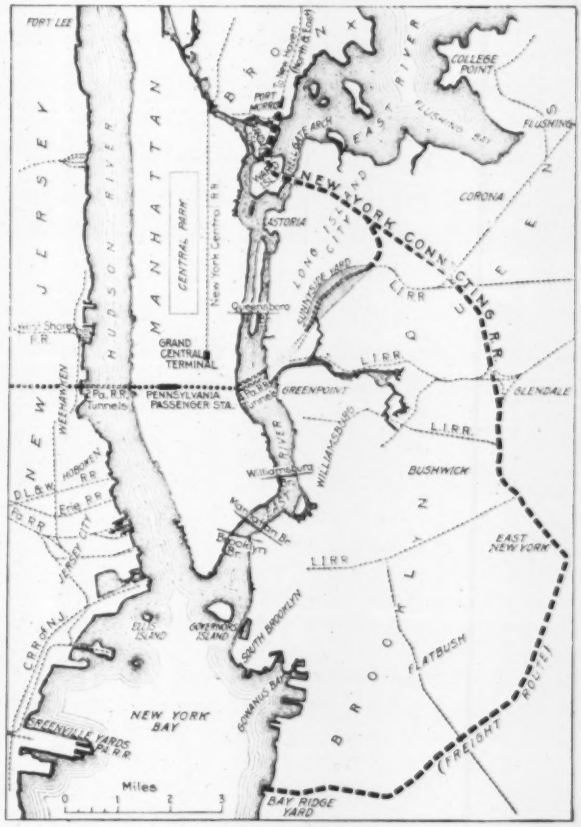
But the money so far spent is only half the final cost. When the whole line, including the freight connection, is completed the total expenditure will be 30 millions. A net income of a million and a half dollars must be earned each year to pay the interest on this vast sum!

The Project Nearly 25 Years Old

Though the great cost and the boldness of the project stamp it as a modern enterprise, yet it was conceived a quarter-century ago. It was associated in the beginning with two other remarkable construction schemes, one of which has since been realized. The first was the project for a Hudson River suspension bridge, planned in the early nineties to carry the traffic of all the railroads terminating on the New Jersey shore over into Manhattan—by way of a 2,800-ft. span! The other was the Steinway tunnel project, to connect New York with Long Island City across the East River about the line of 42nd St.

Men of both enterprises saw the connection between their schemes and realized that by their combination it might be possible to bring Pennsylvania R.R. trains over to Long Island. Austin Corbin, of the Long Island R.R., O. W. Barnes, promoter and engineer of the original Steinway tunnel, Samuel Rea, of the Pennsylvania, and Gustav Lindenthal, the suspension-bridge engineer, were leading figures in the schemes. Some of them, looking even beyond the New Jersey-Long Island idea, saw the possibility of linking the system up to the New Haven railroad, using the islands in the East River as stepping-stones from Long Island to the Bronx. A reconnaissance was made, the outlines of the project sketched far enough to estimate its feasibility and cost, and the preliminary steps were taken toward making it a future reality. A franchise was secured by Barnes. Later, Boller & Hodge, engineers, made another set of plans.

When in 1900 the Pennsylvania R.R., having just taken over the Long Island R.R., suddenly threw its energies into the New York station scheme and started the construction of tunnels under both rivers, the Hudson bridge project had to be dropped, and it has been dormant since that time. But the Connecting railroad with its Hell Gate crossing remained a live element in the general

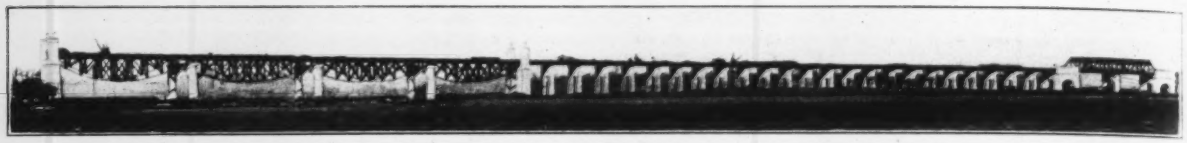


MAP SHOWING NEW YORK CONNECTING R.R. THROUGH NEW YORK CITY

scheme. Waiting on the progress of the tunneling, it was not put forward to an active stage until 1906 and again—after being shelved by the stringency of 1907—in 1912.

Samuel Rea and Gustav Lindenthal have stayed with the Connecting railroad project from its earliest days until now. The former, president of the Pennsylvania R.R., is also president of the New York Connecting R.R., and its guiding spirit. The latter is chief engineer of the line, and as such has set himself as striking a monument as if the huge Hudson River suspension bridge had come to be built.

The bridge and viaduct portion of the line, extending from 142nd St. in the Bronx four miles to Sunnyside yard, comprises the difficult work of engineering and construction. Three miles of it consists of steel spans on concrete piers; the easterly mile is fill retained between high concrete walls held together by tie-rods.



VIADUCT SECTION OF NEW YORK CONNECTING R.R. BETWEEN HELL GATE BRIDGE AND THE BRONX MAINLAND
Little Hell Gate Bridge to the left; Bronx Kills Bridge to the right; steel viaduct in middle

This latter portion, the Eastern Viaduct, is new in type of design as well as in execution. With a maximum height of 65 ft., it would have required very heavy walls but for the ingenious device of tying across with rods (2¼-in. rods spaced 10 ft. apart vertically and horizontally) so that the concrete walls are mere slabs that hold the earth in the 10-ft. panels. Even so the results would have been clumsy if ordinary methods of filling had been employed. By placing selected fill in thin layers and tamping it with pneumatic rammers, a consolidated fill was obtained whose pressure against the walls is relatively slight; and to make the condition permanent in spite of water, drain wells of dry stone were built every 10 ft. along each wall. By these means it was possible to get along with very thin concrete walls.

The calculations for this structure were given in full in *Engineering News* of May 6, 1915, p. 886.

The Hell Gate Arch, Largest in the World

A span of 995 ft. 1⅜ in. between centers of bearings, a rise of 220 ft. from skewback to soffit, topped off by a 40-ft. crown depth, and a four-track solid-floor deck with reinforced-concrete slab carrying ballast-and-tie roadbed, are structurally the defining facts that make the Hell Gate crossing the largest arch and one of the two heaviest bridges in the world—weighing 52,000 lb. per lin.ft. From another standpoint, however, it is just as prominently characterized by its highly successful æsthetic design, resulting from the collaboration of Mr. Lindenthal and the noted architect Henry Hornbostel. Men of æsthetic appreciation have called it the most beautiful bridge in America—which means at least that the design is good.

General drawings and typical details of the arch were presented in *Engineering News*, Jan. 8, 1914, p. 59, and during last summer the progress of erection was recorded in these columns by numerous photographs.

The American Bridge Co., the largest organization of its kind anywhere, found the construction and erection of the bridge an undertaking that taxed its facilities. Work in the shops began late in 1913, with new, specially devised methods and equipment. In March, 1915, the first steel was erected. After a season of fast, systematic work, on Oct. 1, 1915, the arch was closed. By the successful transfer on that date from the cantilever condition of erection to the arch condition, which made the structure permanently secure against accidents of construction, the builders accomplished the formidable part of their task.

Before steel erection began, however, great difficulties had been encountered in securing the foundations. The west, or Wards Island, abutment proved to be so located—as the result of misleading borings—that rock was from 60 to 120 ft. below ground, shelving down away from the arch. The simple foundation originally planned for had to be converted into a most complex group of pneumatic caissons, sunk to rock and keyed together to make an integral mass.

Details of Viaduct and Bridges

Two other river bridges are included in the East River crossing. The Little Hell Gate bridge, between Wards and Randalls Islands, is for its size quite as individual and interesting as the large arch. It has four skew deck spans, of 292½ ft. each. The engineer chose the inverted bowstring form, a type of truss that had disappeared from bridge practice. Using a 50-ft. center depth and two trusses for the four-track width, the chord stresses were very heavy. The bottom chord is a chain of eye-bars, and for these the largest bars ever made were secured—16x2⅜-in. bars with 16-in. pins.

The bridge crossing Bronx Kills to the mainland at Port Morris is designed as a trunnion bascule, but is built for the present without counterweights and machinery, these to be added later when called for. It has two 175-ft. leaves, meeting on a middle rest-pier; they are through spans, with Pratt-type trusses 45 ft. deep. Caisson foundations for the piers had to be sunk to a depth of 90 ft. below mean low water.

The long stretch of steel viaduct is made up of spans generally 60 to 90 ft. long—though there are 130-ft. spans—set at heights of 30 to 120 ft. above ground.

BRIDGE OVER POTTER AVE., IN ASTORIA, AND A PORTION OF THE CONCRETE RETAINING-WALL VIADUCT
Potter Ave. bridge has three spans on rocker posts; one end fixed

Most of the girders are 8 ft. deep. In all cases there are eight girders, braced together in pairs, forming in effect four single-track bridges.

Throughout, the floor is made of four reinforced-concrete slabs (or troughs) in which a 14-in. depth of ballast will carry the track.

The whole undertaking requires 90,000 tons of structural steel, besides 5,000 tons of reinforcing steel used in concrete. There is 450,000 cu.yd. of concrete. The arch bridge alone contains 19,000 tons of steel.

PRINCIPAL DATA OF HELL GATE ARCH

Span—1,016 ft. 10 in. between tower faces; 995 ft. 1⅜ in. between centers of bearings; 977 ft. 6 in. center to center of end hinges.

Arch—height from center of end hinges to center of top chord, 140 ft. at ends; 260 ft. at center. Height to center of lower chord, 220 ft. Greatest height above mean high water, 310 ft. Clearance above mean high water, 135 ft.

Towers—height above ground, 240 ft.

Width, 93 ft. between centers of railings; 60 ft. between centers of trusses.

Bottom chord, 6½ ft. wide, 11½ ft. deep at ends, 7½ ft. deep at center; maximum section, 1,384 sq.in.

Heaviest single piece, 185 tons (shipping weight 150 tons).

Load—the arch carries four tracks on ballasted concrete floor; total dead-load, 52,000 lb. per lin.ft. of bridge; assumed live-load, E60 on each track.

Material, high-carbon steel.

Rivets—heaviest, 1¼-in. diameter, 10-in. grip (field rivets).

Gusset plates—largest, 10x17½ ft. by 1⅝ in.

End shoes are of cast steel and weigh 275 tons each.

Arch trusses were assembled at the shop for drilling holes for field connections.

Arch erected by cantilevering from both ends, each half being held by temporary backstay trusses which carried heavy counterweights at the rear ends. Larger part of backstay material forms part of the permanent structure.

The towers—of reinforced concrete with granite facing architecturally treated. Long Island tower founded on rock in open cut 20 ft. deep. Wards Island tower rests on 21 concrete caissons sunk under air pressure to rock at a depth of from 58 to 120 ft. below ground surface. Total masonry in towers, 110,000 cu.yd.

Maintenance Records; Concrete Roads in Michigan

The annual report of the Board of Supervisors of Wayne County, Michigan, for the year Oct. 1, 1914, to Sept. 30, 1915, contains some interesting data on the cost of maintaining the famous Wayne County concrete roads, some of which are now seven years old. The boast is made that with 125 mi. of concrete road to date it has never been necessary to take up and replace as much as a 25-ft. section. With 45 mi. more road to maintain, a sum of $5,178 less was spent for maintenance in 1915 than in 1913.

Maintenance and repair work which was required has been promptly performed. This consisted principally of cleaning out and refilling expansion joints and the repair of pockets of inferior concrete caused by clay or some other foreign material getting into the mixture. Usually no maintenance is required during the first year.

Outfit and Work of Maintenance Crew

The maintenance crew consists of seven men. A team and a tar kettle complete the outfit. The foreman is paid $5 a day; the driver with his team, $5 a day; tar-kettle man, $3; two laborers, $2.50 a day each; and two laborers, $2.25 a day each. The tools consist of several wire-bristle brooms, a wheelbarrow, a couple of shovels, a tar bucket and sprinkling cans. Two men are utilized to sweep all cracks or spalled joints clean with the wire brooms, after which the man with the tar can fills the cracks with tar heated to 225 deg. F., allowing it to stand for a few moments to prevent it from bubbling. The tarred cracks are then covered with clean coarse dry sand, spread with a shovel. Pit holes are similarly treated. An excess of tar and sand is used, and traffic is allowed to iron out the surface. The tar used is a special mixture of Tarvia A and Tarvia X.

Where an imperfection in the concrete exists, which does not extend through the road but is over an inch in depth, the hole is cleaned out and carefully dried; it is then painted with hot tar, after which it is filled with stones of suitable size graded to fill the voids as nearly as possible. The stone is tamped or rolled into place. Hot tar is then poured over the patch, the quantity being gaged so that the tar will be taken up by the remaining voids without any large excess being left on the surface. Coarse dry sand is then spread over the patch with a shovel. Holes of lesser depth and any joints from which the filler has wholly or partly disappeared are treated the same as cracks and defective joints. The maintenance crew covers from 1 to 3½ mi. of road per day, and one trip over the work yearly is usually all that is necessary. In 1915 the maintenance crew went over the entire concrete mileage by the middle of August.

Attempts to Maintain Bituminous Carpet

There are 2 mi. of concrete road where the entire surface is covered with a bituminous carpet. The same mixture of Tarvia is used for maintaining these 2 mi. Instead of sand, washed and screened pebbles are used. It is necessary to resurface about one-third of these 2 mi. annually, in addition to touching up spots here and there throughout the entire season. The method followed has been to sweep with wire brooms the spots to be treated, after which the tar is applied. The pebbles are then spread over the tar from wheelbarrows or a wagon and left for the traffic to embed in the tar. The surfaces of these roads become wavy under traffic and are said to be not as desirable as a plain concrete wearing surface, either from the standpoint of the comfort of the user or of economy in maintenance.

Some repairs have also been made which were two or more inches deep, by cleaning out the holes, painting them with a cement grout and filling the cavity with a concrete mixture of the same proportions as that used in the construction of the original pavement; for these the concrete is mixed to the same consistency, as nearly as possible, as that of the original construction. The repaired portion is cured by being kept wet for at least seven days and protected from traffic until thoroughly hardened.

A Railway in Panama, in the Province of Chiriqui, is under construction and will be completed in May. According to a description of the new line, by John E. Tiedeman, in the bulletin of the "Pan-American Union," the railway will have a total length of 62 mi. extending from a port on the Pacific at Pedregal, 300 mi. north of the city of Panama, up to the head of the Caldera valley at the foot of the Chiriqui volcano. In a distance of 33 mi. from the sea coast the railway attains an elevation of 4,500 ft. The district penetrated is subject to heavy rainfalls during the rainy season, the average at David being 34 in. per month. This makes the culverts, bridging and drainage for the line very costly. Heavy rock ballasting is necessary to hold the roadbed. Maximum grades on the line are 5%, but such heavy grades are exceptional, most of the inclines being on a 3% grade. The track is 36 in. gage and the total cost of the line will be about $1,760,000.

Huge New Orleans Screw Pump Shows 80% Efficiency

Two articles are presented on the tests of the first of eleven 12-ft. motor-driven screw pumps discharging storm water from the New Orleans drainage system. The first article, by Prof. W. H. P. Creighton, of Tulane University, describes the conduct of tests which showed a pump efficiency of 76 to 80%—compared with 70% expected. The second, by George G. Earl, General Superintendent of the Sewerage and Water Board, discusses the great improvements in carrying off storm water secured by the characteristics of the new pump, which is better adapted to the work in hand than are ordinary centrifugals.

Testing the 12-Ft. Wood-Nordberg Pump

By W. H. P. Creighton*

A test was made to determine the amount of water that one of the new New Orleans drainage screw pumps could lift, and the efficiency of performance. The results show that the pump raised 559 cu.ft. per sec. through a height of 5.6 ft., and 519.8 cu.ft. per sec. through 7.6 ft., the pump making between 75 and 76 r.p.m. and the efficiency varying between 76 and 80%. The specifications required a maximum deliv- - of 550 cu.ft. per sec. through a lift varying from 5 o 9 ft. when the motor was making 75 r.p.m. The efficiency expected was 70%. It is readily seen that the pump complies with these requirements. High efficiency was maintained over varying lifts.

*Dean, Department of Technology, Tulane University, New Orleans.

The pump tested is one of 11 similar units installed or to be installed in the various drainage stations for pumping the storm drainage of the City of New Orleans. These pumps, as noted in *Engineering News*, Jan. 15, 1914, were designed by the Sewerage and Water Board of the City of New Orleans (George G. Earl, General Superintendent, Alfred Raymond, General Manager of Drainage) under the immediate direction of A. B. Wood, Mechanical Engineer of the Board, who holds patents covering this type of pump. The stations containing these pumps are designed and built under the same supervision. The pump castings and parts were manufactured and erected by the Nordberg Manufacturing Co., of Milwaukee, Wis. The motors were manufactured and installed by the Allis-Chalmers Manufacturing Co., of Milwaukee, Wis.

There was a great deal of trouble in obtaining suitable conditions for this test. The only way, however, to obtain conditions under which the water discharged could be measured by certainly accurate and universally credited methods was to run the test with a gradually decreasing level of water on the suction side of the pumps. Accordingly the greater portion of the test was conducted with levels on the suction of the pump, giving less submergence of the suction intake, and materially lower than would exist in actual operation, and with a condition of water and of approach to the suction intake less favorable for good pump efficiency than that which will exist when these pumps are doing the work which they are built to perform.

The object of this test was to measure the cubic feet of water the pump could lift from one level to another and to find out the efficiency of this operation.

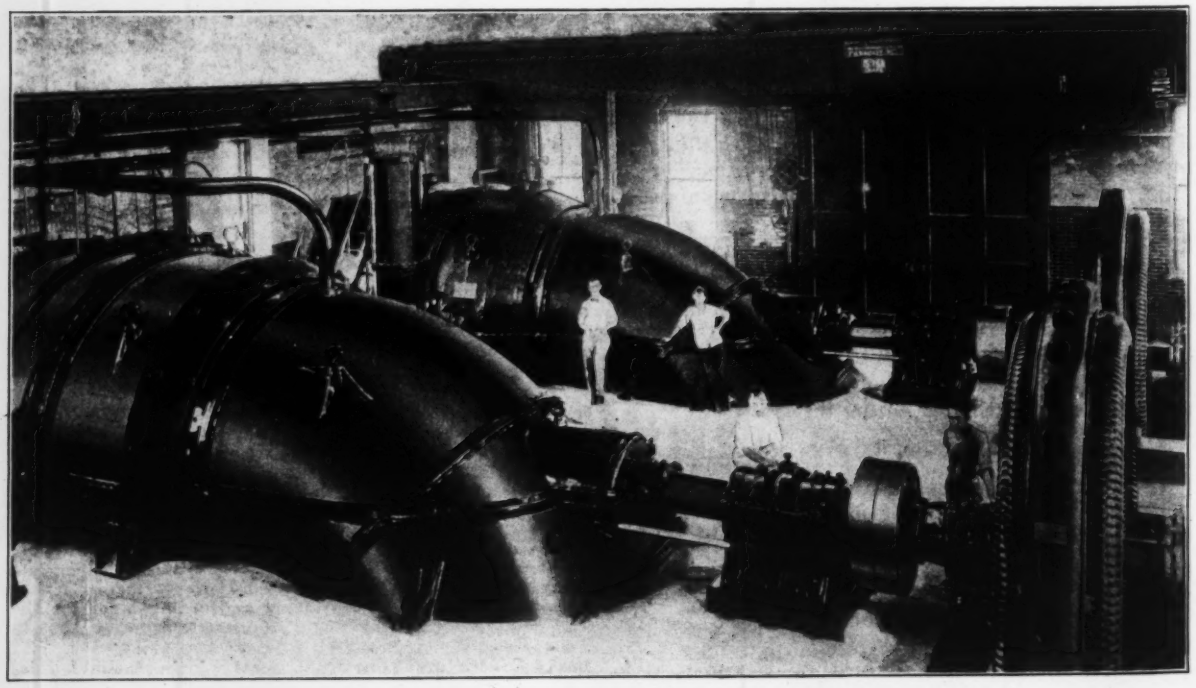


FIG. 1. TWO 12-FT. SCREW PUMPS IN DRAINAGE STATION 1, NEW ORLEANS

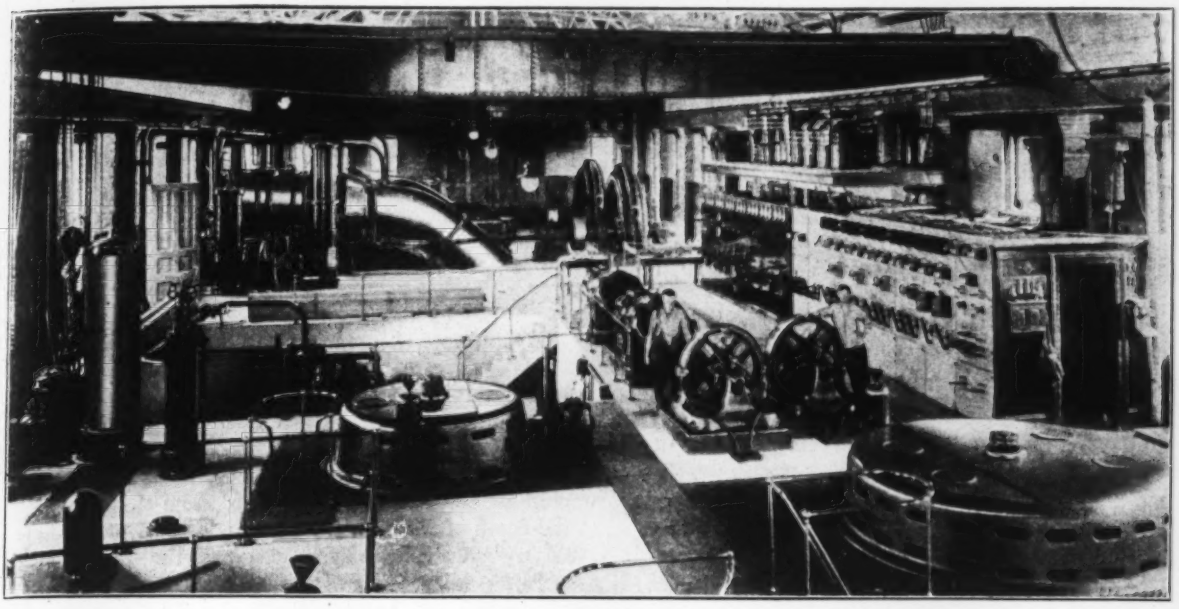


FIG. 2. INTERIOR OF NEW ORLEANS DRAINAGE PUMPING STATION 1

The pump tested is in drainage-pumping station No. 1, at the intersection of Broad and Melpomene St. Two canals lead into the suction basin of this station—one in Broad St., and the other in Melpomene St. The discharge from the station can go either wholly or in part in either of two directions—down Broad St. to drainage station No. 2, (this canal is not yet finished), or out Melpomene St. to drainage station No. 6, the direction being controlled by the hydraulically operated swinging gates shown on the general plan.

The pump proper (Fig. 1) consists of a cylindrical casing, 12 ft. inside diameter and 13 ft. 9 in. long, lying with its axis horizontal and containing the impeller and the stationary or diffusion blades. The diffusion blades are mounted on a water-tight, cone-shaped housing, within which is located a self-aligning main bearing and a marine-type thrust bearing. The inner cone is 8 ft. in diameter at the largest section and is reached through an oval-shaped, water-tight manhole and passage opening through the top of the pump. In this way this inner cone or chamber is at all times accessible for an inspection or adjustment of the bearings, even during the operation of the pump.

On the suction side the pump is connected to a cast-iron 45° bend, through which the shaft, provided with the proper stuffing-box, extends. Between the stuffing-box on the pump and the motor there are another bearing and a flexible coupling. The 600-hp. motor driving the pump is a three-phase 25-cycle 6,000-volt synchronous machine, with an amortisseur field winding.

The part of the suction pipe beyond the cast-iron 45° bend is built up of riveted sheet steel and increases in cross-sectional area, being 15 ft. in diameter at the lower end. The discharge pipe is made of riveted sheet steel, bolted to the pump casing. It contains a 45° bend and sections of uniformly increasing diameter, that of the lowest being 15 ft.

The pump-shaft center line is 2½ ft. above the operating floor of the station. The suction and delivery ends being always under water, the pump is primed by exhausting the air after the motor is in operation.

The total electrical energy input into the armature of the motor was measured by the two-wattmeter method. The true readings were derived from the calibration curves as sent by the maker's laboratory. The electrical input into the field was measured by voltmeter and ammeter (millivoltmeter with 200-amp. shunt). True readings were taken from calibration curves sent by the Electrical Testing Laboratories, of New York City.

The gage to read the elevation of the water in the suction basin consisted of a float chamber of 12-in. cast-iron pipe, set vertically and provided with a float and rod with a pointer. The pointer moved against the gage board, marked off in feet and tenths, and set so as to read the elevation of the suction basin in feet (Cairo datum).

The level of the water in the discharge basin was read on a gage board, graduated to read elevation (Cairo datum) in feet and tenths, and set accurately as to elevation on the inside of a stilling box. On the general plan (Fig. 4) are shown the positions of the discharge and suction gages and also the swinging gates used to regulate and control the head in the discharge basin. The head given in the log is, therefore, the actual head from suction-basin level to discharge-basin level.

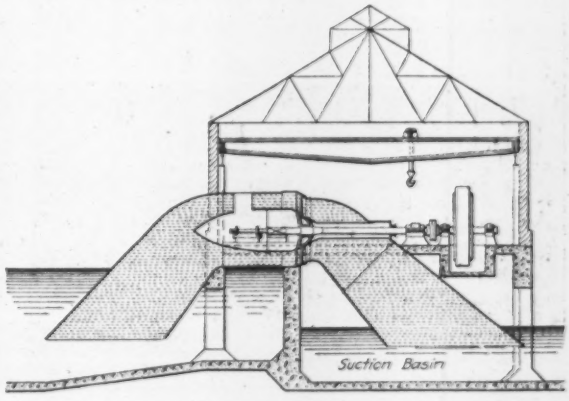


FIG. 3. SECTION THROUGH 12-FT. SCREW PUMP

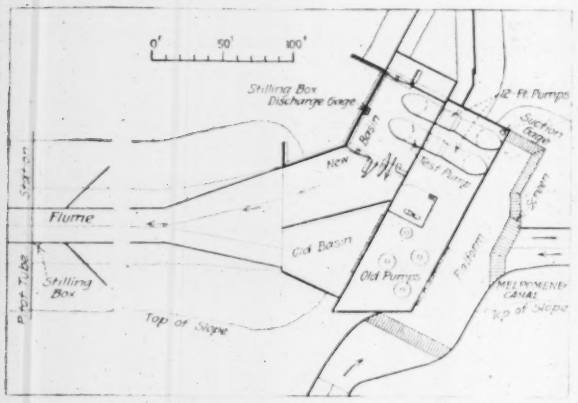


FIG. 4. PLAN OF DRAINAGE PUMPING STATION 1

The velocity of the water in the canal on the discharge side was determined by pitot-tube readings. The tubes used in this test had been used by the same observers on numerous other tests and have been frequently checked against reservoir displacement. The static and velocity water columns are brought to a common reading board, provided with a movable brass scale, graduated so as to read velocity in feet per second.

The discharge canal is of the general section shown in Fig. 7. About 600 ft. beyond the station the woodwork of the canal sides was built up to make a flume, timber lined on sides and bottom, with wing walls to form the approach. The cross-section of this flume also is shown in Fig. 7, and through it the discharge from the pump has to pass. Across this flume, above the level to which the water would rise, was placed a 6x12-in. timber to be used as a bridge, from which the pitot tubes were set, supported and read.

The lower section of the canal (below the line *X-Y*, Fig. 7) is triangular. This triangle was considered as divided into eight sections of equal area, and the pitot tube held at the center of gravity of each of these sections while reading. This tube was called the "long tube," because it had to be extended vertically in order to reach the lower points from the bridge. The average of these eight readings gave the mean velocity of the water in this section of the canal.

The level of the water in the flume was not constant, so a stilling box was fitted to the side of the flume and connected to the flume through a pipe. The level of the water in the flume was then read in this stilling box by means of a hook gage, so graduated that it gave the depth of the water in the rectangular part of the flume (Fig. 7). The velocity of the water in this part of the canal was read with a second pitot tube, exactly similar to the other, but with shorter vertical water-column connections. This was called the "short tube." This rectangular section of the canal was considered as made up of ten sections of equal area, and the tube held at the center of each rectangle when taking a reading. The average of these ten readings was taken as the mean velocity of the water in this section of the canal. The depth at which this pitot tube was set was determined from the readings of the depth of water in the rectangular part of the flume, as shown by the hook-gage readings, the tube point set at half the depth of this water.

Method of Conducting Pump Test

Before the test, all wire connections were checked to insure all instruments reading in the correct direction. The setting of the suction and discharge-head gages was double checked with an engineer's level. The cross-sectional area of the flume was measured with a steel tape. Finally the watches of all observers were set exactly together, the pump was primed and the test started.

Simultaneous readings of electrical input, field current, suction gage, discharge gage, the depth of water in the flume, were made every 2½ min. The water readings were taken by starting from one side of the flume and working toward the other, reading each point in order. One observer with the long tube would go first, reading the lower points in order, followed immediately by another observer with the short tube, reading the upper points in order. A third observer recorded the readings and the time of readings. As soon as the trip across had been

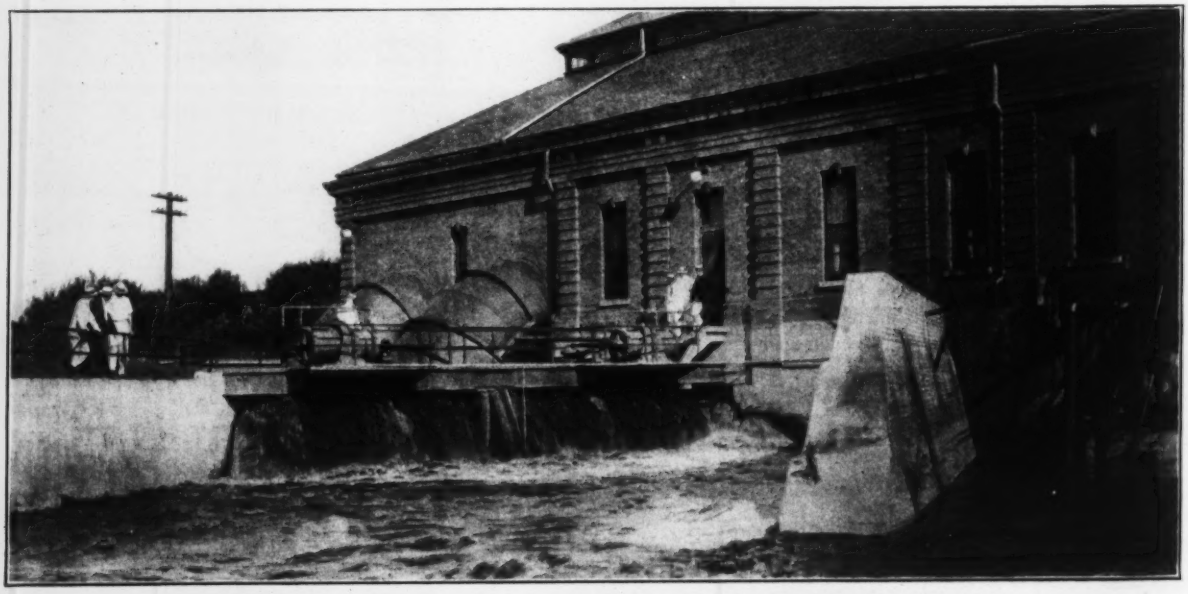


FIG. 5. DISCHARGE OF ONE PUMP OVER AND THROUGH RUDDER GATES

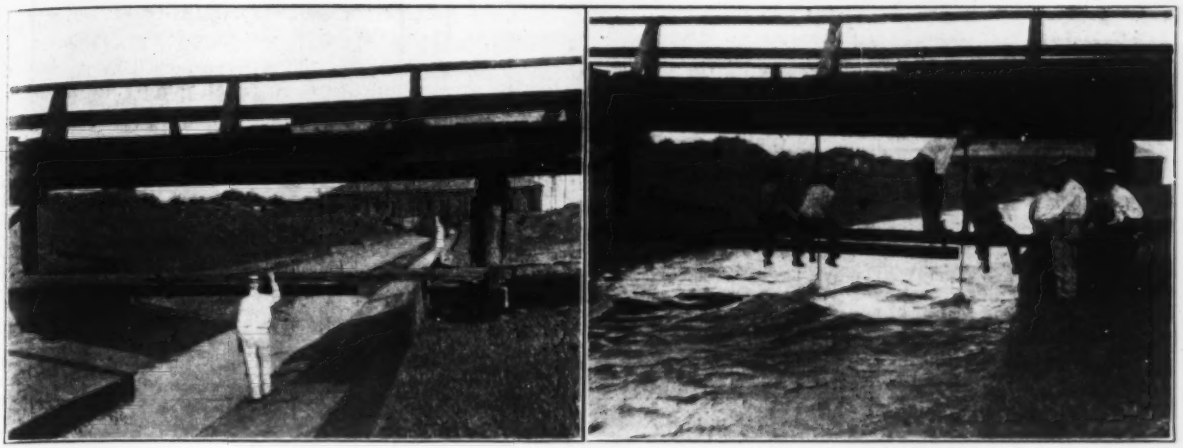


FIG. 6. CANAL AT MEASURING STATION; DRY AND DURING PUMP TEST

made by each tube, constituting one set of readings, another set was taken by going back across in the opposite direction, reading each point in the reverse order. In this way six complete sets of observations were taken, and from these the quantities of water pumped were calculated.

Corrections for Test Conditions

As the test could not be made under normal conditions of operation, certain artificial conditions had to be created. The water on the suction side of the canal was allowed to accumulate by not pumping daily. To secure the necessary lift, the gates controlling the direction of discharge from the new discharge basin were almost entirely closed, so that an artificial discharge head in the basin of any desired height could be obtained by increasing or decreasing the opening of the gates.

Under these artificial conditions, when the water on the suction side was higher than on the discharge side, there was 1.83 cu.ft. per sec. leakage through all the gates and valves of the old station. When conditions are reversed, the amount of leakage becomes uncertain, but it is certain that it could not be less.

A more important correction, which, however, could be quite accurately measured, arose also from the artificial conditions necessary. The water was discharged into an empty canal 3 mi. long. As the length of the water flow increased, the head necessary to cause flow at the pump end increased, which resulted not only in a constant increase in the area of the water cross-section at the measuring platform 600 ft. from the pumping station, but also in a reservoir of water of increasing volume, which had been discharged from the pump and did not pass the measuring station during the time the pitot-tube traverse of this cross-section was being made. This reservoir effect was considerable until the pump at the other end of the canal was started and the water level of the canal assumed a nearly constant slope.

In like manner, as the level of the water in the new discharge basin back of the controlling gates varied during each run, a correction had to be made for this change of volume. This correction was small during the first part of the test, but was considerable near the end, as the discharge basin was being lowered to maintain a nearly constant head on the pump.

The output of the motor was obtained by substracting the total losses in the motor from the total input. After the test the motor was uncoupled from the pump and run light with the same field and at the same speed, to determine the core loss, etc.

The motor efficiency guaranteed by the manufacturer was 92½%. Just after the official pump test, the motor efficiency was calculated as just described and found to be 94.3%. As certain very small losses, called "load losses," could not be measured from lack of sufficient apparatus, the efficiency under test conditions as found by the manufacturer—94.0% and 94.07%—was used in calculating pump efficiency instead of 94.3%. The results of the test are summarized in the accompanying table.

SUMMARY OF TEST ON 12-FT. WOOD SCREW PUMP
Sept. 27, 1915

R.p.m.	Input to Motor, Hp	Efficiency of Motor, %	Input to Pump, Hp.	Water Levels—Suction	Water Levels—Discharge	Total Head, Basin to Basin	Flow, Cu.Ft. per Sec.	Water Hp.	% Efficiency, Combined, Basin to Basin	% Efficiency Pump, Basin to Basin
75.8	494.7	94.00	465.0	14.903	20.475	5.572	559.09	354.0	71.6	76.1
75.2	515.5	94.00	484.6	14.347	20.358	6.011	541.29	369.7	71.7	76.3
75.0	543.4	94.07	516.8	13.654	20.340	6.686	529.79	402.5	73.3	77.9
75.0	589.2	94.07	554.3	12.903	20.300	7.397	516.92	434.5	73.7	78.4
75.5	597.7	94.07	562.3	11.989	19.600	7.611	519.80	449.6	75.2	80.0
75.5	597.8	94.07	562.4	10.801	18.392	7.591	510.08	440.0	73.6	78.2

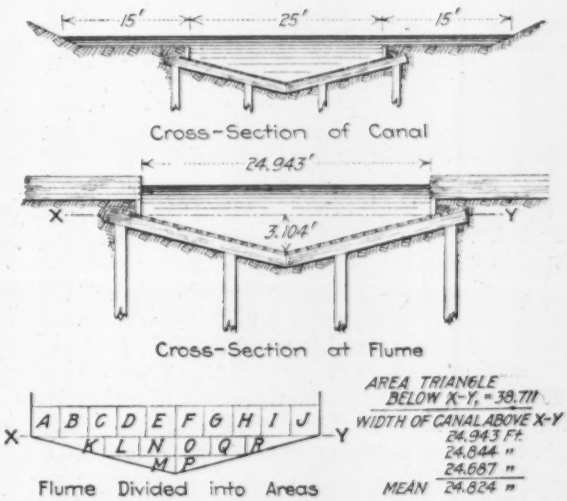


FIG. 7. DISCHARGE CANAL AND FLUME SECTIONS

As a number of preliminary tests had been made, the observers were well trained for their duties. Much credit is due to Technical Engineer S. G. F. Haas, who had charge of all preliminary tests and who worked up the results of the test; to Assistant Engineer Louis T. Frantz, who had charge of electrical calculations and observations; to all of the observers of the Sewerage and Water Board staff and to the student check observers who aided the writer in supervising the test.

The tendency to increase the quantity of water discharged at constant speed of operation as the lift decreases from point of best efficiency exists in both types, but is slightly greater in the centrifugal pump; to do this, however, the centrifugal pump frequently requires a constantly increasing applied brake horsepower, with the result that its power requirements must be applied with an especial view of meeting the overload, which its lack of efficiency at its lowest lift produces. The new screw pump, on the other hand, when operating at a constant speed shows a rapidly decreasing power demand as its lift decreases, and while it still maintains an increasing discharge, it only uses its maximum power at its maximum lift.

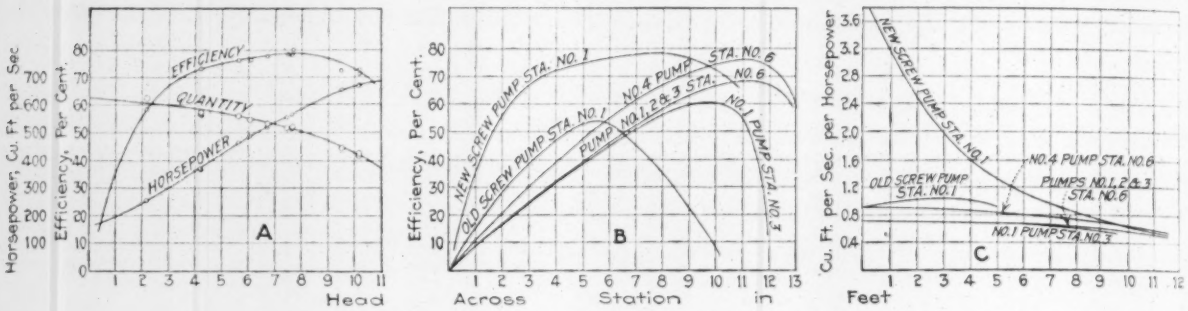

Horsepower, Cu. Ft. per Sec.
Efficiency, Per Cent.
EFFICIENCY
QUANTITY
HORSEPOWER
A
Head
Efficiency, Per Cent.
NEW SCREW PUMP STA. NO. 1
OLD SCREW PUMP STA. NO. 1
NO. 4 PUMP STA. NO. 6
PUMPS NO. 1, 2 & 3 STA. NO. 6
NO. 1 PUMP STA. NO. 3
B
Across Station in Feet
Cu. Ft. per Sec. per Horsepower
NEW SCREW PUMP STA. NO. 1
OLD SCREW PUMP STA. NO. 1
NO. 4 PUMP STA. NO. 6
PUMPS NO. 1, 2 & 3 STA. NO. 6
NO. 1 PUMP STA. NO. 3
C
Feet

FIG. 8. COMPARATIVE PERFORMANCE CURVES OF NEW AND OLD DRAINAGE PUMP AT NEW ORLEANS
A—Efficiency, delivery and power curves of Wood screw pump. B—Efficiency-head group for five pumps. C—Head-specific delivery group for five pumps

What the Wood-Pump Test Means to New Orleans

By George G. Earl*

The new screw pumps of the New Orleans Sewerage and Water Board give their best efficiency at 7- to 8-ft. lift and show a better figure for 7½ ft. than the best of the board's old centrifugal pumps at its best point—11-ft. lift. But the advantages of accessibility, operation, first cost, etc., are more than sufficient to dictate use of the screw pumps even if their power-consumption characteristics were the same as those of the centrifugals.

These points, however, I will pass for the present, since it is the significance of the vastly different curves of characteristics which Mr. Wood has obtained in these pumps to which I particularly desire to call attention. The improvement is apparent in the examination of the diagram of comparative-efficiency curves (*B* in Fig. 8). It seems to me, however, that the local benefit is better illustrated by comparing the cubic feet per second discharged per applied brake horsepower for the 75 r.p.m. screw pump and for the other groups of pumps.

The best of these pumps, measured by this yardstick, adds only 50% to its capacity per applied brake horsepower as its lift drops from its point of maximum efficiency, which is 11 ft., down to 0, while the new screw pump increases its capacity per applied brake horsepower 300% from its lift for maximum efficiency at 7½ ft. down to 0.

A centrifugal pump for low lifts with the best characteristics will maintain about $\frac{8}{10}$ of its maximum efficiency for a range of lifts equal to about $\frac{6}{10}$ of the lift at which said maximum efficiency is obtained. These new screw pumps for low lifts maintain $\frac{8}{10}$ of their maximum efficiency for a range of lifts approximately $1\frac{2}{10}$ times the lift at which such maximum efficiency is obtained.

In a system, like that in New Orleans, operated electrically with power and pump capacity designed to give the required output under those low-lift conditions which require the greatest quantity of discharge, the power requirement to operate all units will be much less with screw than with centrifugal pumps. Since as the lift increases, the available flow approaching the stations decreases and fewer pumping units have to be operated, the power required to operate the pumps at a low lift will still suffice to operate enough units as the lift increases to take care of the decreasing flow. With pumps driven by power units capable of some speed variations, the characteristic of the screw pump is such that available power can be utilized at an increased speed at lifts far below the rated lift, without the serious sacrifice of efficiency which an increase of speed entails with centrifugal pumps.

Experience of Sewerage and Water Board

The function of a drainage-pumping station is to maintain the water level on its suction side lower than the water on its discharge side. When it has just ceased to do this, it becomes an obstruction instead of an asset, and its crucial test is its capacity to discharge more and more water with less and less power per unit discharged as the lift decreases and the necessity to pump therefore is most urgent. At the most crucial point, if the power and the pumping capacity are properly adjusted, one will be able to pump with the same power expenditure from three to five times as much water per applied brake horsepower with pumps having the characteristic of these new pumps as with pumps having characteristics like those indicated in the diagram for the earlier pump installations in New Orleans—or with the best design of centrifugal units.

*General Superintendent, Sewerage and Water Board, City Hall Annex, New Orleans.

The experience heretofore of the Sewerage and Water Board has been that during great storms when lifts were much below the rated lifts, the older forms of pumps overloaded their motors and also overloaded the power stations, so that all pumping-station units could not be maintained in service. With the 11 additional screw pumps and less than enough additional power to operate them at their rated lift, because the flow at rated lift can never supply all pumps, this condition will be reversed. The decreasing amount of power required to operate the new pumps as their lift decreases will more than compensate for the excess amount required by the old ones when their lift decreases and the necessity to pump is at its greatest.

With six great pumping stations at which the maximum run-off from storms arrives at varying time intervals ranging from a few minutes to about 1½ hr., the matter of increasing the power output of the generating stations from, say 1,000 hp. to over 12,000 hp. and starting up pumping units as fast as the approaching flow will permit is a difficult and vital one.

In actual operation, therefore, the new screw pumps will be started first, as soon as the water approaching the station is sufficient to supply them, because whether the first lift is at above or below the rated lift their flat efficiency curve will give a less absorption of power per unit of discharge when power is being accumulated and is at a premium. After all the screw pumps are in operation, if the approaching water warrants, the other pumps will be started. If the approaching water is in excess of the capacity of all pumps at rated lift, the water level on the approach side will rise faster than the level on the discharge side, the lift will decrease and the power saved by the decreased power consumption of the new pumps will suffice to keep the old ones in operation until the required rate of pumpage is not in excess of the capacity of the new pumps, when the old pumps will be stopped and the new ones continued in operation, because they not only pump the increasing lift due to the exhaustion of the suction water more efficiently, but they are capable of pumping it to a much lower level, that is, through a higher lift than the old pumps.

Advantage of Pump at Siphon Summit

The placing of a screw pump at the summit of a siphon instead of submerging it, as appears to have been the usual practice, makes it accessible for maintenance and avoids the necessity for the very expensive gates required to give accessibility to submerged screws. Where the pumps are operated by synchronous motors, it also avoids the necessity for large and very costly check gates to prevent backflow in case the motors go out of step, which check gates in the older installations in New Orleans have proved not only high in first cost, but very expensive and difficult to maintain in good condition.

Further, in order to start the submerged pumps of the older installation with synchronous motors, it was necessary to have telephone communication with the power station and to slow down an engine and bring the pumps up to speed gradually, and when in synchronism to throw them over the operating bus. This was a tedious and delicate operation, not always successfully accomplished on the first trial, and much time was lost in its accomplishment when time was of utmost importance.

In designing the new extensions it was recognized that the new pumping units must be as large as possible, and their method of starting more simple and certain than that before described if they were to be of the greatest possible use. By adopting screw pumps we had precedent for much larger units than have ever been built in centrifugals, and by setting these screw pumps in the summit of a siphon we are enabled to start them in an empty case by the mere throwing in of a switch, after which the air is exhausted from the pump case and the pump takes its load gradually without any telephoning to the power station or any chance of being put out of step.

Improving the Old Drainage Pumps

There are only two attendants on watch at one time at any of the drainage-pumping stations. Owing to this improved method of starting and to friction clutches that are being built to connect between the old pumps and motors, which will permit these pumps also to be started by the throwing of a switch to start the motor when disconnected from the pump and the subsequent gradual application of the load through the friction clutch, it will be far easier for the operating forces to handle the stations after their capacity has been more than doubled than it was before. At the inception of storms as the flow approaching the station increases, it will be far more easy to start the necessary pumps required to keep pace with such increasing flow than it has been heretofore.

ENGINEERING SCHOOLS

Massachusetts Institute of Technology

Writing engineering reports is being taken up in the new courses of the Massachusetts Institute of Technology on engineering administration. The scheme is to give out an engineering problem to the students (third-year men) and require a report which may be in the shape of a technical article, popular story or concise outline with details in appendices, after the style of formal reports.

The date of the dedication of the new Technology buildings in Cambridge has been fixed as June 14, 1916. This is in Commencement Week. The Chairman of the Dedication Celebration Committee is C. A. Stone.

The stonework of the initial structures is practically completed. Interior floors are being finished. Rough plumbing is all in place and installation of fixtures is under way.

Brown University

Arrangements have been completed for the regular admission at mid-year as well as in September of new students, candidates for the degree of A.B. and Ph.B. The new plan goes into effect in February, 1916, at the beginning of the next semester. Brown is the first of the New England colleges to meet the increasing demand from the mid-winter graduates of high schools and academies that they be allowed to enter college without six months' delay. To facilitate admission the university will hold a special set of entrance examinations prior to the opening of the second semester. Examinations conducted under the supervision of the College Entrance Examination Board and certificates issued by schools having that privilege will also be accepted. No extensive change in the present system of continuous year courses in the curriculum has been made, a special schedule for the new students being arranged which will allow them to fall in with the general program the following autumn

Field and Office

Model Roadbuilding Plant of a Kentucky County

Fayette County, Kentucky, of which Lexington is the county seat, is reputed to have established a remarkable record in road improvement, begun in 1896 by the purchase of toll roads for $352,000. Two years ago it was decided to do the roadbuilding with county day labor and county-owned equipment rather than by contract. There are about 385 mi. of roads in the county system, all but five of which were originally surfaced with waterbound macadam.

The county has a centrally located supply station of 400 tons' capacity. Sand, stone, cement and asphalt are brought in railway cars. The asphalt is stored in steam-heated reservoirs having a capacity of 24,000 gal. There is a warehouse for storing cement, machinery, etc. Stone is obtained from 13 quarries, owned by the county but operated by contractors. There is a central crushing plant operated by inmates of the county workhouse. From the crushing plant the stone is transported by freight cars to the central supply station and unloaded by gravity into concrete storage bins from tracks overhead. There are eight sand and stone bins, each of 50 tons' capacity, which are emptied by gravity through a traveling chute (see Fig. 1).

The other county-owned equipment includes a White "good roads" truck, a White pressure asphalt distributor, two 4-cu.yd. Troy trailers (Fig. 3), an elevating grader, a scarifier, two road rollers, two concrete mixers and a rotary broom. With this equipment and a force of 20 men the county during the last season rebuilt 22½ mi. of old macadam, built 30 concrete bridges and culverts, laid 8,000 ft. of culvert pipe and distributed 80,000 gal. of asphalt in the surface treatment of 25 mi. of roads. As

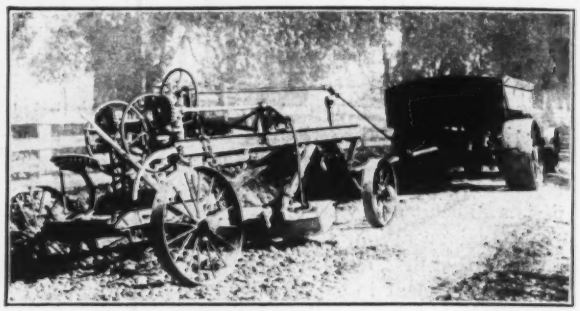


FIG. 2. MOTOR TRUCK HAULING GRADER ON FAYETTE COUNTY ROAD WORK

an example of the efficiency of the present system, it is said that a concrete bridge on which the bids from contractors varied from $750 to $1,100 was built by county day labor under the supervision of the County Engineer for only $400—a comparison which shows not merely saving of profit but efficiency of work.

In 120 working days, May 1 to Oct. 31, the truck and trailers hauled 5,882 tons of stone—an average rate of 49 tons per day, for an average distance of 4 mi., at a cost, including operation and maintenance, of $9 per day, 18.4c. per ton or 4.6c. per ton-mile. The truck was fre-

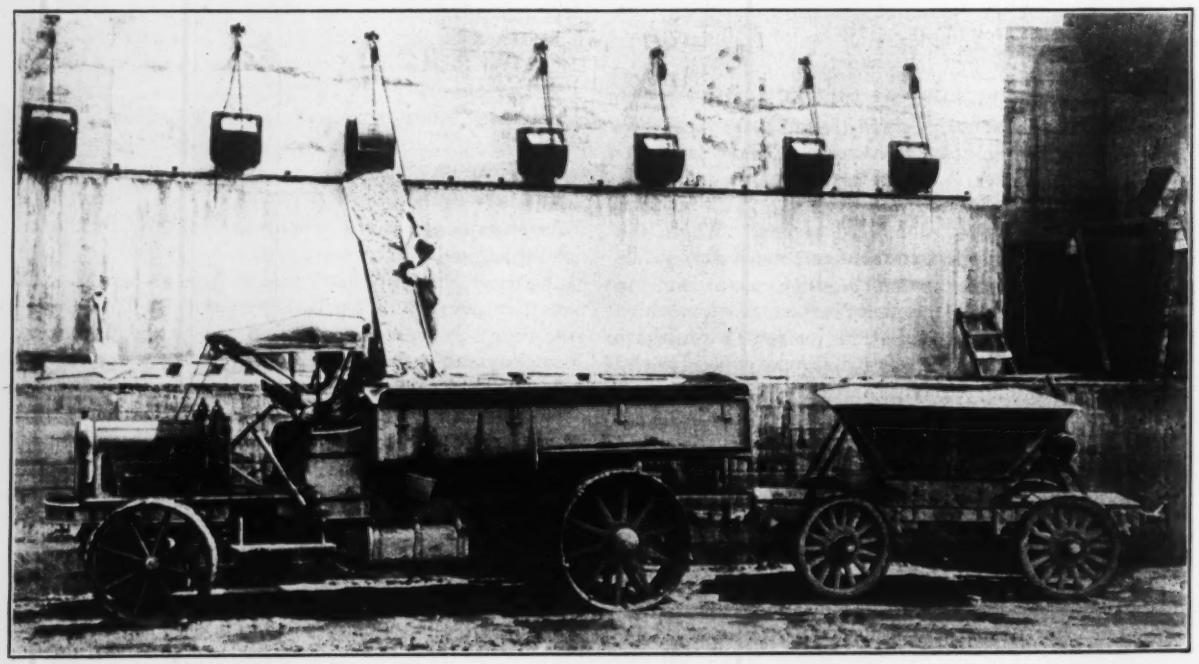


FIG. 1. CENTRAL SUPPLY STATION: CONCRETE STONE AND SAND BINS EMPTIED BY TRAVELING CHUTE

FIG. 3. HAULING STONE FOR FAYETTE COUNTY ROADS, KENTUCKY

quently used to pull a scarifier and occasionally to draw the elevating grader as well as a common road grader (Fig. 2).

Fayette County embraces about 370 sq.mi. and has a population of 56,000. The county engineer is Robert W. Davis, Lexington, Ky.

Laying a Monolithic Brick Pavement in Car Track

Bricks laid on a mortar bed on a concrete foundation that completely incases the steel ties and a part of the rails is the form of street-pavement construction adopted for Tuscarawas St. W., Canton, Ohio. As T-rails are used, special nose brick are laid at the gage side for the wheel flanges. Wood ties were used on parts of the track because access to the car barns and summer-resort traffic would not permit the interruption of the car service necessary for this type of construction.

After the old track was removed and the excavation completed, the rails were bolted to the steel ties, the track brought to grade by blocking under the rails, and the concrete (1:3:5, with gravel aggregate) was poured in one operation to form a monolith slab inside and outside of the rails.

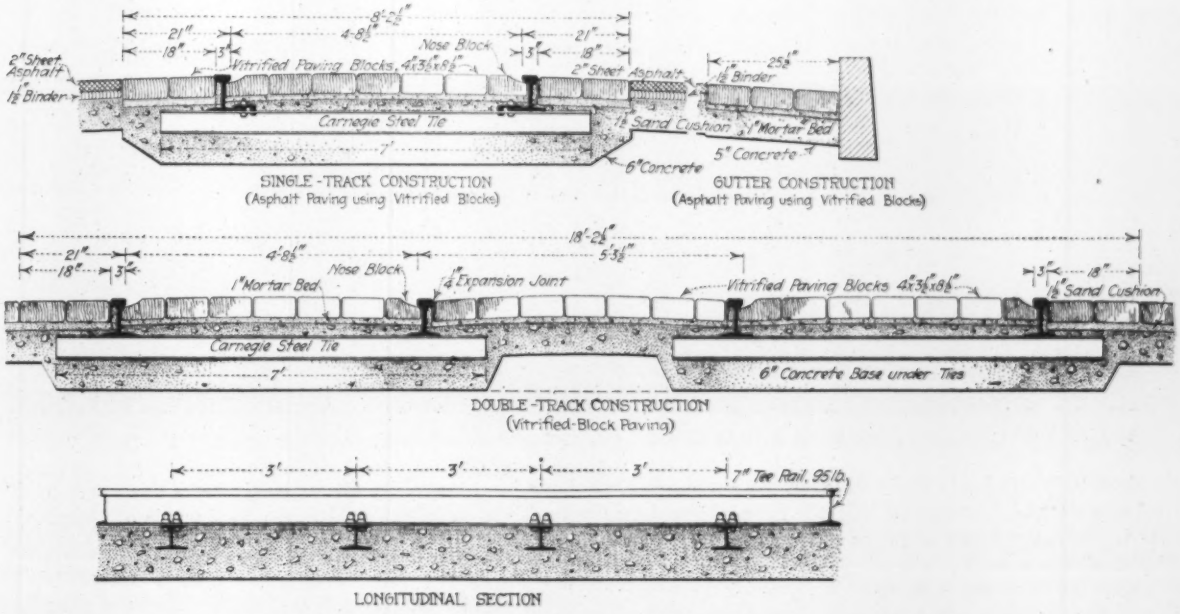
No traffic was allowed for ten days after the concrete was placed. Where there was only a single track, traffic was maintained by means of a portable track laid upon the old pavement and provided with cross-overs. No traffic was allowed during the laying of the brick pavement nor until the grout filler had set.

Where there were double tracks the brick pavement was laid on one side at a time—on one track and the devil strip simultaneously, the cars being operated on the other track only. The running of the cars on the one track did not appear to affect or disturb the grout filler on the devil-strip side, apparently because of expansion strips along the outside of the rail, which took up the vibration in the track.

Where wood ties were used a dry-mixed concrete was thoroughly tamped under and around the ties and under the rails. There is to date no evidence of any movement in the brick surface where steel ties were used, but as was expected, there is some movement where the wood ties were used.

The brick (wire-cut-lug) were laid ¼ in. below the top of the rail, to avoid the hammer of car wheels. This does not in any way offer obstruction to the passage of wheels of either slow- or fast-moving vehicles; in fact, the small amount of jarring experienced by the occupants of vehicles passing at all angles over the tracks has been commented upon.

These street-car tracks carry interurban cars weighing about 35 tons. The same type of construction is used



BRICK-PAVED STREET-RAILWAY TRACK CONSTRUCTION, CANTON, OHIO

in Canton on all street-railway tracks being reconstructed or on new tracks, except where only city cars are used. Here T-rails weighing 85 lb. per yd. are used instead of 95 lb. as were used in this particular case.

The street-railway company does all the work except furnishing and placing the mortar bed and wearing surface. The cost of the brick paving in the street-railway area was $1.26 per sq.yd. The excavation cost 40c. per cu.yd. The city engineer of Canton is W. E. Sarver.

Steel Pipe Lasted 22 Years

By E. G. Markley*

In the fall of 1893, Milton Flory, owner of a grist mill in the then village of Bangor, Penn., built a steel intake pipe and installed a turbine to take the place of an open millrace and waterwheel, as well as to make way for certain municipal improvements and eliminate occasional losses due to overflow from the race.

The distance from the dam to the mill was about 3,200 ft. To build the pipe, about 700 sheets of steel $\frac{3}{16}$ in. thick by 5x8 ft., and 96,000 rivets were required. The material was regular boiler steel, purchased from the International Boiler Works. The rivets were heated in a hand furnace and driven by hand at a local machine shop; six sheets were riveted at a time and the 30-ft. section was delivered to the laying point. A gang of seven men laid the pipe on blocking placed in the bed of Martins Creek. About 90 ft. of pipe was placed each day.

The steel pipe has made a remarkable record when it is considered that it was half submerged and constantly exposed to the weather. The creek has its source in the springs of the Blue Mountain, some 10 or 15 mi. distant, and tests chemically pure with a trace of sulphur.

Traces of deterioration began to appear in the pipe in 1907 in the form of small corrosion holes. These were promptly plugged, but in 1912 the seams began leaking and general deterioration began; numerous plugs and bands were placed each year. At some points no attention was given the leaks, and during the winter months great mounds of ice would accumulate along the pipe, as illustrated. The steel pipe was placed at an expense of about $9,000. Today a 36-in. wooden pipe replaces the steel at a cost of $6,000, and it is the hope of the owner that it shall supply water to his mill for at least 40 yr. The static head today is about 44 ft., with a pressure of about 20 lb. at the mill.

*Secretary, S. Flory Mfg. Co., Bangor, Penn.

An Adjustable Building Shore

The shores shown in the accompanying view are of a type patented by H. W. Roos, of Roos Bros., contractors of Cincinnati, Ohio, and have been used successfully in a number of concrete buildings. Their special feature is

BUILDING SHORE ADJUSTABLE AS TO HEIGHT

the ease with which they can be adjusted to heights between 8 and 16 ft.

The lower section of each shore is a 4x4-in. stick, 8 ft. long, to the top of which are spiked 2x4-in. pieces that serve as guides for the two 2x4-in. struts which make the upper 8-ft. section. Along the sides of the lower 4x4 are nailed 1-in. channels, the outstanding legs of which have been sawed to form ratchet teeth that engage the band-iron tongs fastened to the lower ends of the 2x4-in. sticks.

In operation the tongs grip the ratchet teeth when the upper strut is under load, so that the control of the shore is automatic. Each shore weighs about 60 lb.

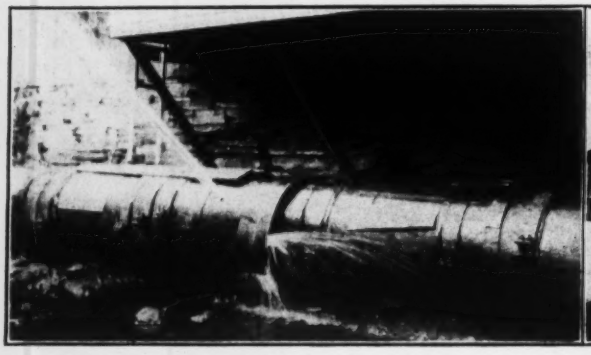


FIG. 1. REPAIRS ON FLORY PIPE, AND A LEAK

FIG. 2. WINTER SCENE ALONG LEAKY STEEL PIPE

Ditching and Grading Machine

A Bowman ditcher and grader is used by the Norfolk Southern R.R. for clearing roadbed ditches, widening fills and trimming the slopes of cuts. Machines of this make have been used by the Southern Pacific Co. and the Missouri, Kansas & Texas Ry. with uniformly good results. On the Southern Pacific the ditcher in a single month handled 22,320 yd. from 8,650 lin.ft. of ditch, at a cost of about 6½c. per yd., to which was added 3½c. per yd. for the work of shifting signals and cattle guards, dressing the ballast and trimming the ditches and carrying them away from the ends of the cuts. In 18 mo. this machine averaged 8,720 cu.yd. per mo. at a cost of 15c. per yd., or 20c. including repairs and the miscellaneous work just mentioned.

The machine is a 50-ft. steel flat-car and is equipped for four kinds of work—excavating side ditches, plowing hard material, spreading dumped material and dressing the slopes of cuts. All operations are controlled by compressed air supplied from large reservoirs, which are charged at 100 lb. pressure by three brake pumps on the car. Steam for these pumps is taken from the locomotive. The weight of the machine complete is about 70 tons.

The car carries two steel gallows-frames, each supporting two jib cranes with 4-yd. scraper buckets suspended in a bail and handled by two vertical air cylinders. In soft material the bucket will fill to about 5 yd. The larger cylinder, 24x60-in., operates the hoisting chains, while the other, 12x60-in., operates the dumping chain attached to the rear of the bucket. With the machine in place and ready to start, as in Fig. 1, the two forward buckets are lowered, and the locomotive pulls ahead slowly. When the buckets are loaded they are swung up, and the rear buckets are dropped and filled. The machine is then hauled rapidly to the dumping point, where the buckets are dumped, and returned for another load.

FIG. 2. PLOWING ROADBED WITH DITCHING MACHINE

For spreading material dumped along the track on fills or in yards there is a scraper blade hinged against the side of the car, as shown beneath the rear bucket in Fig. 1. Where the material is too hard for excavating by the buckets or where hard material is to be loosened for widening the roadbed beyond the reach of the bucket, the

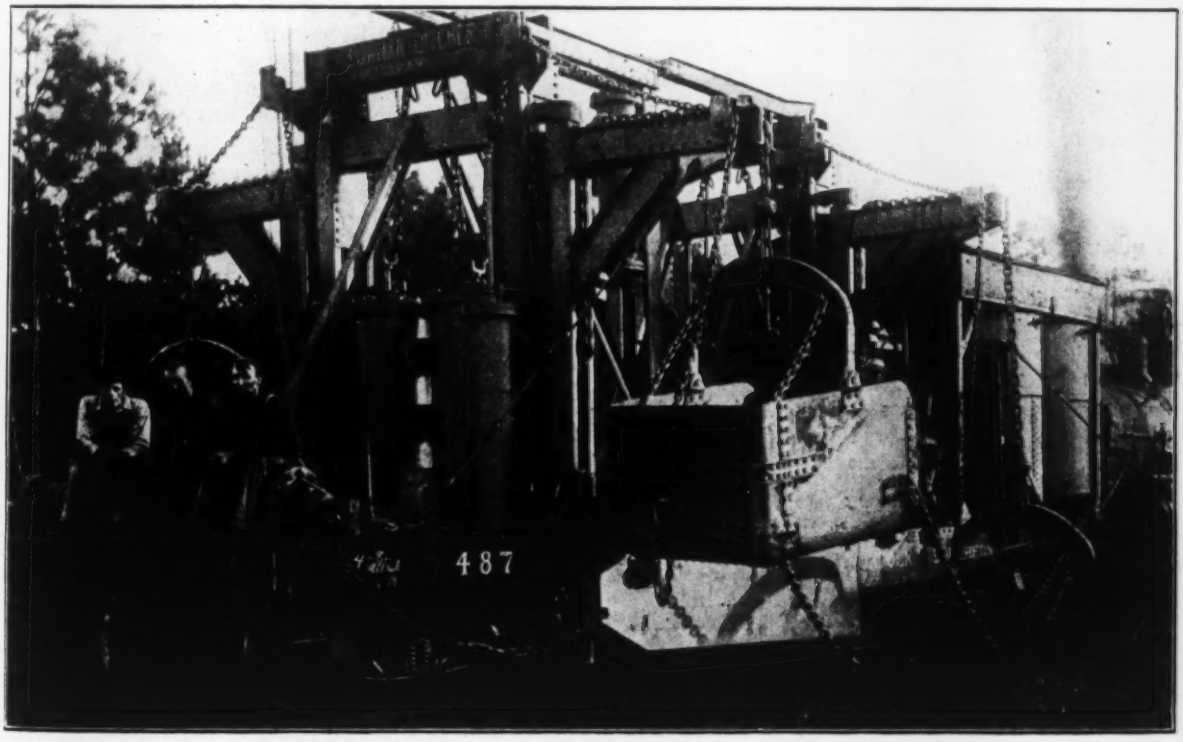


FIG. 1. RAILWAY DITCHING AND GRADING MACHINE; NORFOLK SOUTHERN R.R.

The forward bucket is shown lowered and the rear one raised. Beneath the latter is the scraper board or leveler. The vertical cylinders operate the buckets. The horizontal cylinders at the rear are to govern the position of a plow attachment.

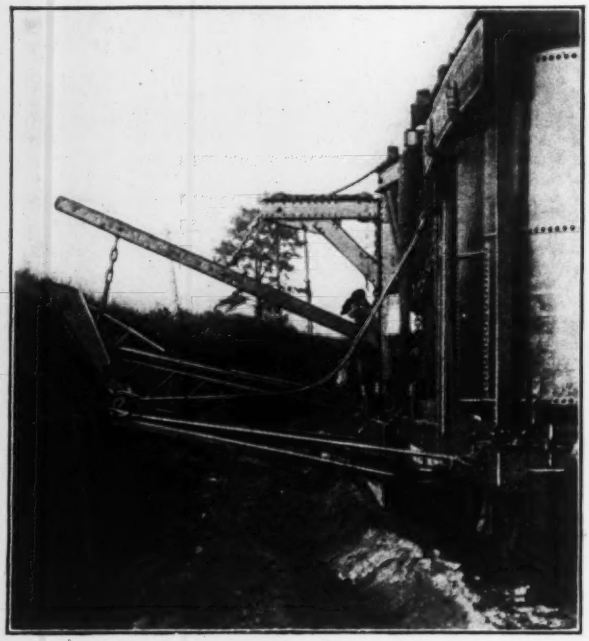


FIG. 3. TRIMMING THE SLOPES OF CUTS WITH THE DITCHING MACHINE

machine handles a heavy plow, which is illustrated in Fig. 2. For dressing slopes or widening cuts there is a scraper attached to a pair of telescopic struts, as shown in Fig. 3. The scraper is used also to form a shoulder for the ballast.

The machine requires a crew of only three men in addition to those on the locomotive. The machine was invented by Benjamin Bowman, of Springfield, Mo., and is sold by the T. W. Snow Construction Co., Ellsworth Building, Chicago.

Repairing an Open Joint in a Submerged Water Main

By Edward M. LeFlufy*

A submerged 12-in. cast-iron flexible-joint water main through False Creek, Vancouver, B. C., failed recently by a "draw-out" caused by settlement. When examined by a diver, the pipe was found to have separated completely at the point *S*, Fig. 1, leaving an opening about 1½ in. across.

A split sleeve (Fig. 2) was designed to inclose both the bell and the spigot, and in order that this sleeve should bolt together properly and that the packing glands should

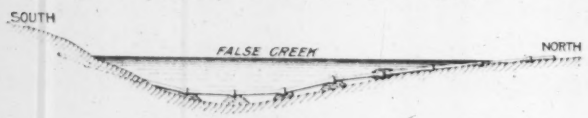


FIG. 1. REPAIRING BREAK IN 12-IN. SUBMERGED WATER MAIN, VANCOUVER, B. C.

enter without binding, it was necessary to get the pipes *A* and *B* (Fig. 1) into line. This involved raising the lower end of *B*. To avoid overstraining the other flexible joints in this operation, it was found necessary to raise and support three other joints in the pipe line. The supporting material was concrete, mixed on a scow and lowered in bags to the diver, who deposited the bags as required.

There was no objection to raising the main above the bed of the creek as indicated, as False Creek is in process of being filled in for industrial purposes and a railway terminal.

The packings used in this repair sleeve consisted of two rubber gaskets at each end, placed in position so that the joint on the inner gasket is not opposite that on the outer one.

*Assistant Engineer, Water-Works Department, Vancouver, B. C.

Erecting a New Building Around an Older One

Erecting a new suburban bank building around an older and smaller one that was kept in service during the operations is an interesting piece of structural work in Detroit. The Highland Park State Bank, at 3030 Woodward Ave., having a very large business owing to its proximity to large manufacturing plants, had outgrown its quarters. It was very desirable to avoid moving to a temporary location, and it was necessary therefore to plan some way of erecting the new structure without interfering with the business of the institution.

The old building was 50x57½ ft., two stories high, the first floor being used for banking purposes and the second floor for offices. The new building is 50x150 ft. Its main portion is only one story high and has steel columns in the side walls supporting roof trusses which span the entire width. There is secondary steel framing for the mezzanine floors.

Temporary partitions were built just inside the walls of the old structure, and the roof was supported by shoring. The exterior walls were then removed so that the contractor could proceed with the erection of the new steelwork and the exterior face of the new building. The height of the new building is sufficient to allow the roof trusses to be placed above the roof of the old building.

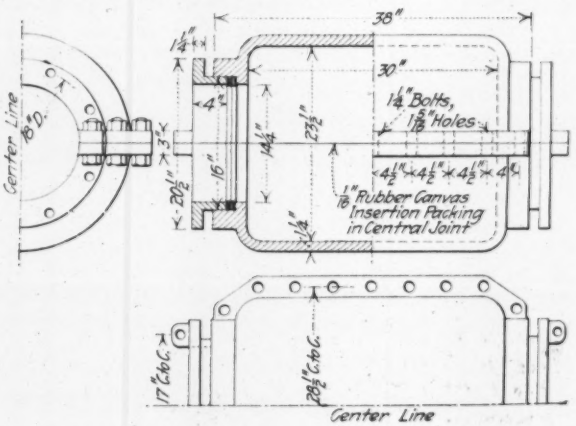
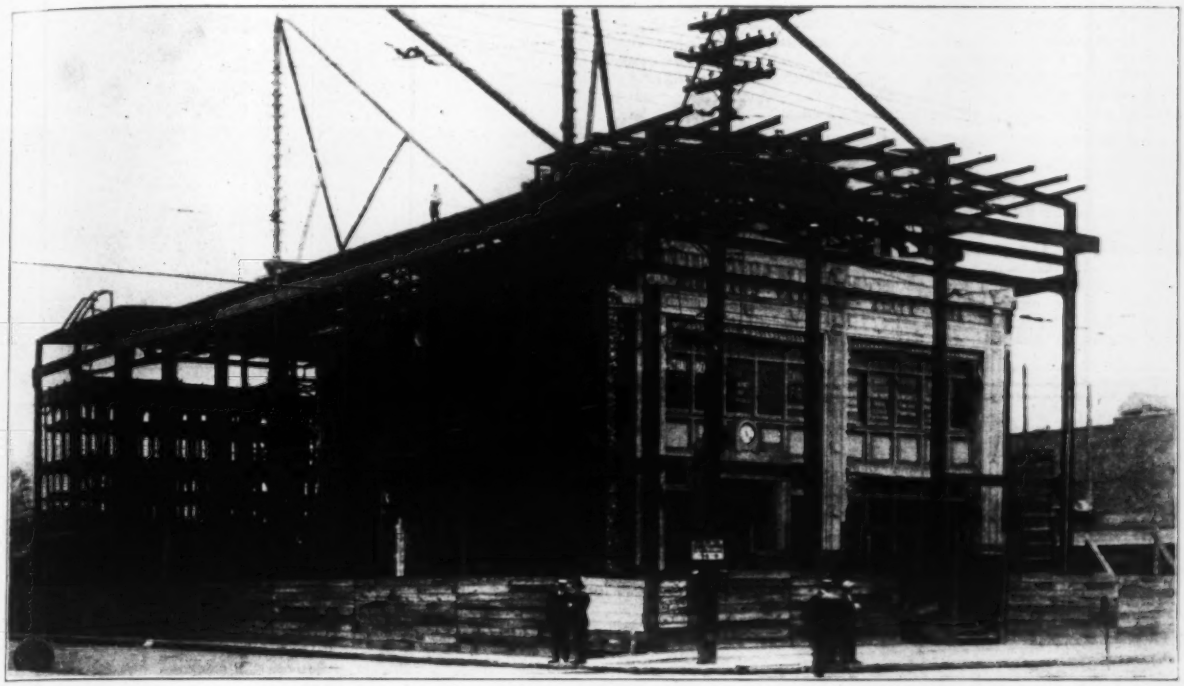


FIG. 2. SPLIT SLEEVE FOR INCLOSING BELL AND SPIGOT OF BROKEN WATER MAIN

The rear of the new building (beyond the older one) will be completed, and the bank will then move into this portion while the old structure is being removed and the new front portion completed.

The accompanying view shows the new steel framing and roof practically completed and the forms in place



ERECTING A NEW BANK BUILDING AROUND AN OLD ONE

for the concrete floors of the rear portion. The old building has its front and roof intact and a temporary partition for the side. At the right, beyond the old building, is part of the new brick exterior wall. The erection was done by means of stiff-leg-derricks.

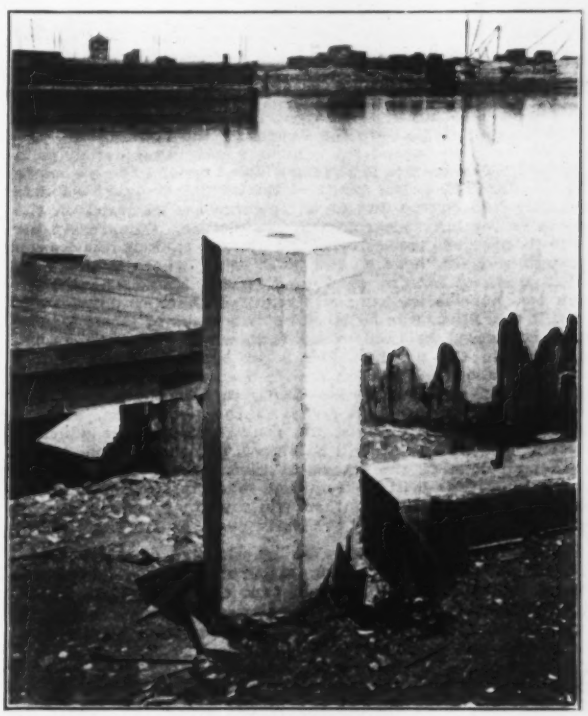
The architect for the building is Albert Kahn, and the contractor is the Albert A. Albrecht Co., both of Detroit.

NOTES

Line-Throwing Guns similar to those in use by the life-saving service for throwing lines to wrecked vessels have been installed at certain lighthouse stations on the Alaska coast to facilitate the passing of lines from the station to vessels approaching with supplies. Similar guns are to be placed on the lighthouse tenders to be used in passing lines to other vessels in heavy weather.

Tests of the Friction Coefficient of stone on stone for possible use in dam design were made by H. Shifrin and reported in a thesis for the degree of bachelor of science in civil engineering at Washington University in 1913. The article by E. L. Lasier on a similar subject in "Engineering News," July 22, 1915, p. 156, served to bring out the thesis from its place in the university archives. Mr. Shifrin's tests were made on small blocks of shale and limestone about 72 sq.in. in area, which were planed to surface and polished by rubbing one face on another. The frictional values were found by comparing the pull required to move horizontally a block piled with varying weights and resting on the other block. The pulls varied from 0 to 275 lb., and the loads from 0 to 475 lb. Average values of the coefficient of friction were as follows: Shale on shale—dry, 0.60; shale on shale—wet, 0.54; limestone on shale—dry, 0.59; limestone on shale—wet, 0.51; limestone on limestone—dry, 0.75; limestone on limestone—wet, 0.71. The first two of these figures may be compared with the corresponding values—0.61 and 0.54—found by Mr. Lasier.

Concrete-Capped Pile as Construction Benchmark—In building the Essex power station on the meadows in the southeast part of Newark, N. J., the Public Service Electric Co. engineers at the start of their operations set a permanent benchmark to be used all through the construction period. It was placed on the river bank (the whole site is in marsh), and to be immovable had to be carried down to solid ground. A pile was driven and the exposed portion of the pile was surrounded and capped with concrete, as the view shows. An instrument platform was built around the benchmark, also founded on piles, in order to make observations free from disturbance by the vibration from trains on a railway



CONCRETE-CAPPED PILE-BENCHMARK FOR CONTROL OF CONSTRUCTION, ESSEX POWER STATION

track directly alongside. The work was directed by N. A. Carle, Chief Engineer, Public Service Electric Co., Newark. This benchmark has completed its service so far as concerns the plant as now built (completed late in 1915). However, the station is designed for successive extension, by building additions on boiler house and turbine house, from the present capacity of 50,000 kw. to an ultimate capacity of 200,000 kw.

Sandblasting a Monument—So completely had smoke and dirt reduced to a dull monotone the color of the Soldiers and Sailors' Monument in the Public Square of Cleveland, Ohio, that citizens generally were surprised to learn that the stone in it is of two kinds, dissimilar in texture and color—buff sandstone and bluish granite. Sandblast is being employed to clean the stonework, which will later be heated and filled with liquid paraffin to protect it against the action of the smoky atmosphere and to give a surface which can be washed. It is easy to pick out in the picture the parts which had been cleaned at the time the photograph was taken—namely, the cannon balls at the left of the base of

A $2,000 SANDBLAST RENOVATING JOB

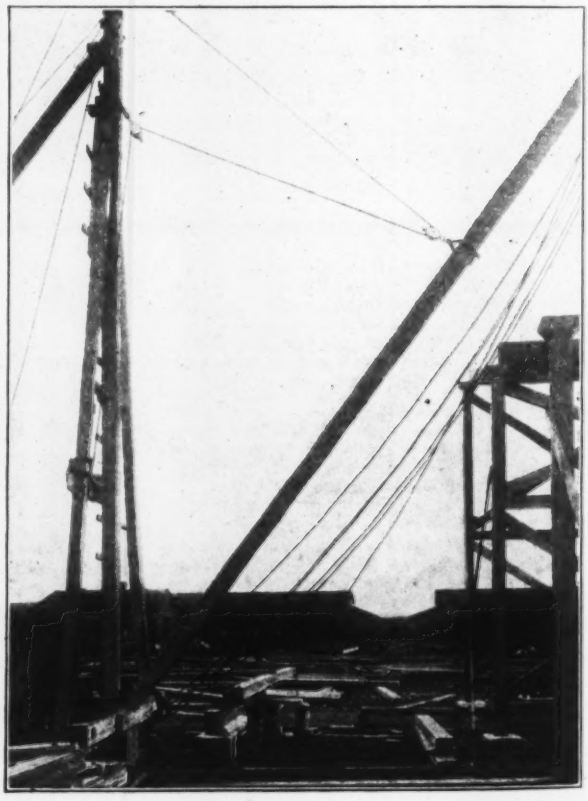
the main shaft, some of the stonework just below the cannon balls and the facade against which the ladder leans. The dust which can be seen above the figures at the right in the picture comes from behind the canvas, where sandblasting is in progress. The granite is the dark areas around the arches in the facade. The power plant of the sandblast outfit consists of a gasoline engine and an air compressor mounted on the wagon in the left foreground of the picture. Compressed air at 30-lb. pressure passes from the storage tank in the wagon through a ¾-in. hose to the sand tank, where it picks up silica sand. A 5-cu.ft. sand tank, which lasted about 1 hr. with two nozzles working and required shutting down work until it was filled, was replaced by two tanks of about 3 cu.ft. each, connected in tandem, so that when one was supplying sand to the air line, the other could be filled. Silica sand cost about $6 per ton and is used over and over. The job is taken at a lump sum—$2,000 in round numbers—and includes putting in eight gratings for ventilation, calking joints in the floor with oakum soaked in oil over which a layer of cement mortar will be placed, pointing all the stonework and cleaning the bronze statues. About three months of working time will be required to complete the job. On account of inclement weather work was suspended in November to be resumed in the spring.—C. E. Drayer.

A Small Stiff-leg Derrick on wheels was used for transporting and setting the concrete curbing of the drives and basins in front of the Kensico dam of the Catskill water-supply, New York City. It is shown by a view herewith. At the time the picture was taken the concrete blocks were being cast and stored at a point about 600 ft. to the right of the derrick. A single hauling line passing over the end of the derrick boom and attached to one of the two drums of the steam hoist snaked the blocks along the ground to a point under the boom, where they were picked up and placed by separate lifting lines. The derrick can of course

USING A SMALL DERRICK TO SET CONCRETE CURB, KENSICO DAM

move itself from place to place in a similar manner, or may be moved long distances by horses or a tractor. The contractor for this work is H. S. Kerbaugh, Inc., 6 Church St., New York City, who has the contract for all the work in connection with the dam, and who has displayed a great deal of originality in methods of construction, as described in "Engineering News" of May 21, 1915, in an article on the masonry construction work.

A Homemade Swinging-Boom Derrick was used to erect the timber framing of the bleachers at the Sheepshead Bay Motor Speedway, described in "Engineering News" of Aug. 19, 1915. The illustration shows the general construction of this derrick. An interesting detail is the joint at the base of the boom. The square timber forming the boom is rounded off with an adz or ax, and this rounded end fits in a corresponding socket carved out of two horizontal timbers fastened to the foot of the mast. The weight of the boom is all that holds it in place. The socket allows of swinging through an arc of about 45°. The motive power employed was a horse.



HOMEMADE DERRICK FOR ERECTING TIMBER BLEACHERS

Editorials

A Prosperous Society

Not many engineering societies have felt it necessary to limit their membership list from the standpoint of numbers. To annex new members, and thus increase the wealth and importance of the organization, is a general and impelling desire, especially among the local technical societies. Nor have many societies the temerity to increase their initiation fees 300% and double their annual dues, in one swoop. In view of this the following statement just issued by the American Iron and Steel Institute may occasion both surprise and envy:

> The active membership list of 1,250 is full, and the associate membership list of 250 has only 8 vacancies. The board of directors decided not to increase the number of members in either class. Temporarily some members eligible to active membership are being elected associate members. When that list shall have become filled, no more members will be electd except to fill vacancies. The board decided to increase the admission fee from $5 to $20 and the annual dues from $10 to $20, effective with the beginning of the new institute year, May 1, 1916.

How To Operate Imhoff Tanks

Highly trained engineers are freely engaged and liberally paid by many American cities to design engineering works that embody the latest theory and practice of technical science. When those very works have been completed, they are often dedicated with elaborate ceremony and a free exchange of congratulations. So far, so good. Then a change comes. The works designed and built with intelligence and skill and dedicated with high pride are delivered up for sacrifice in operation to political place hunters. The money provided for operation may be too little, too much or just about right, according to a variety of chances; but it is sure not to be spent wisely in any event. The operating results are therefore poor, the plant is not properly kept up, and everything goes from bad to worse. Then perchance the original designing engineer gets all the blame for poor results, for which he is as blameless as a new-born babe. The discredited works may then be abandoned, another engineer called in to design and build a plant of some other type and the vicious circle run once more.

In no class of municipal works has this round been run more often or more disastrously than with plants for the treatment of sewage. Taking for present purposes one element of sewage treatment—the removal and partial reduction of settleable solids—it is a notorious fact that many of the original one-story type of septic tank have fallen into disrepute because of ignorance and neglect in operation. The newer type of septic tank, known as the two-story, or Imhoff, or Emscher tank, is generally considered to be more nearly foolproof than the old type; but political vultures may be depended upon to make it other than a thing of beauty and a joy forever.

The Imhoff tank is still relatively new, but fortunately a large percentage of the many tanks of this kind now in use have been operated with a high degree of intelligence—a few even in this benighted country. A considerable body of useful experience with Imhoff tanks has been amassed. Much of this experience has been gained under the direction and still more under the eye of the man whose name the tank bears.

Conclusions based on these and other Imhoff-tank operating data are given by Dr. Imhoff elsewhere in this issue. That he lays no stress on the need of providing skilled operators is due to the fact that he lives in a part of the world where intelligent and skillful operation is so general that it is more likely to be taken for granted there than are technical training and experience in design and construction in the United States.

Routes for Freight Traffic Around Large Cities

A development of recent years in economic freight transportation is the diversion of through freight traffic around important commercial centers, relieving the railway yards at these centers from congestion and avoiding the delays which are likely to occur in the passage through a great city. The larger a city is, the more crowded will be the tracks leading into it and the greater the advantage in diverting through freight around it.

At Chicago, greatest railway focus of the country, the need for freight diversion has created several belt lines around the city; and two or three busy car-ferry lines connect railway ports in Wisconsin and Michigan across Lake Michigan, giving through traffic from the Northwest a direct route east. Experience there shows that the time saved in freight transit by such diversion routes is fully as important to the shipper as the saving in cost. At Baltimore the Pennsylvania R.R. a few years ago built a railway line around the city for the use of its through freight trains. Other belt-line transfer railways at various cities serve the same purpose of diverting through trains around the city, as well as providing for the interchange of cars between different railways.

A railway-traffic problem which has been studied for a generation is the problem of routes for the economical carriage of through freight past New York City without the delays and heavy expense which have always been necessary to send freight through it. Much space is given in this issue to a description of the New York Connecting R.R., a $30,000,000 enterprise of the Pennsylvania R.R. Co., which aims to accomplish this.

Strictly speaking, the New York Connecting R.R. will not take freight around New York City, unless one restricts the term New York City to its former limits of Manhattan Island. As at present planned, the freight cars passing over this road will still have to be transferred by a car-ferry across New York Harbor. It is probable that when the New York Connecting R.R. was first planned, it was intended to send freight trains as well as passenger trains through the tunnels under the North and East rivers. Solid trains of freight cars in a long

procession might be sent across under the rivers and Manhattan Island during those hours of the night when passenger traffic through the tunnels is very light. City authorities, however, always look with suspicion on any attempt to divert freight traffic around a city without stoppage or transfer; and in the grant of a franchise for the North River tunnels to the Pennsylvania R.R., the city authorities insisted on the insertion of a clause restricting the use of the tunnels to passenger traffic only.

The wisdom of this restriction is at least open to question. Possibly some future city administration may be wise enough to perceive that it is to the advantage of New York to have the congestion in its harbor lessened by sending through freight cars underneath the city through the tunnels instead of carrying them in car floats across the harbor already overcrowded with traffic. Even if such an enlightened administration should come into power, however, it is doubtful whether it would have the legal authority to alter the restriction in the franchise.

It may be noted further that through freight cars which pass over the New York Connecting R.R. will have to travel for a long distance over tracks crowded with suburban traffic north of the Harlem River, and on the west side of the Hudson will have to take their chances with a vast mass of other freight cars, destined for the port of New York, which enter and leave the great freight yards there. To secure greatest advantage a loop line for through freight around a city should keep clear of the city's suburbs and terminal yards. Around New York, for example, it should leave the main line in central New Jersey and not rejoin it again until well past suburban territory north of the Harlem River. The topography of the region surrounding New York, however, makes impossible the construction of any such line, chiefly by reason of the gulf, too broad and deep to be spanned by a bridge, which is formed by the Hudson River for many miles north of New York.

More than a quarter of a century ago it was attempted to divert through freight around New York by building a bridge across the Hudson River at Poughkeepsie, 75 mi. north of New York City. The amount of traffic diverted by that route, however, has been trifling compared with what the projectors of that enterprise hoped. The difficult grades and long detours necessary on the railways reaching the bridge on each side of the river were alone sufficient to explain the failure of this route.

Notwithstanding the comparative failure of the Poughkeepsie bridge route, promoters have not ceased to interest themselves in similar projects. At a point only 40 mi. north of New York in the Hudson Highlands is a site where it is possible to bridge the Hudson with a structure of moderate span. The late Gen. E. W. Serrell in the early 90's was at the head of a company which proposed to bridge the Hudson at Anthony's Nose, 5 mi. south of West Point, and spent a considerable amount on construction of the railway approaches. This project, though for many years inactive, has never been entirely abandoned. Railway lines built to reach such a bridge could have grades and distances much more favorable than those on the lines reaching the Poughkeepsie bridge. It is possible that within the next decade some of the other trunk-line railways reaching New York from the West may take up this old project and build another line for through freight traffic around New York to compete with the Pennsylvania's route over the New York Connecting R.R.

Appointing Engineers on the Public-Service Commission

Why have the engineering societies urged the appointment of engineers of ability, experience and reputation as members of state public-service commissions? They have done so first of all because they realize that commission regulation of public utilities is on trial. If regulation is to be made a success, if justice is to be done both to the public and to the public-utility corporations and those who have invested their money in them, then the public-service commissions must be made up of men who can add to the requisite character and ability, knowledge of the work they are called upon to perform.

It is important that public regulation by commission be made a success, because if it does **not** succeed, then public ownership is inevitable. While engineers differ more or less in their ideas as to the desirability or the reverse of public ownership and operation of public utilities, there is general agreement that we do not want to have public ownership and operation forced upon us, and that in many fields the public will be better served if private corporations perform the service under intelligent supervision by public officials.

This situation ought to be clearly understood, if not by the public at large, then at least by the leading business men and the conductors of the better part of the daily press who represent the public opinion that is of chief importance. Engineering societies have not urged the appointment of engineers on public-service commissions in order to obtain a salaried appointment for some particular engineer, but because, as citizens with the public welfare at heart, they appreciate the necessity of appointing the right class of men to administer our public-service commissions.

This is why the appointment of Henry W. Hodge as a member of the New York City Public Service Commission by Governor Whitman, commented on last week in these columns, is of such importance.

Mr. Hodge is an engineer of great ability and reputation, who accepts the appointment at a personal financial sacrifice because he recognizes the opportunity to render an important public service and recognizes also the duty a man owes to his profession and to the public.

The New York Public Service Commission is responsible for the carrying on of the largest engineering enterprise now under way in the world, as well as for the regulation of the corporations operating public utilities, in the greatest city of America. It is of great importance that the engineering profession should be represented on the administrative board which has charge of this work.

The New Orleans Screw Pumps

The great advantage of having an unusual variety of able designers inside an engineering organization built up to carry out a large and difficult piece of important work is well shown by the recent accomplishment of the New Orleans Sewage and Water Board. As noted two years ago in *Engineering News*, the Mechanical Engineer of the Board (who is a well-known pump designer) designed with the aid of his staff eleven huge pumping units which became necessary with the natural growth and extension of the city's storm-water drainage system. This "designing" was not merely the usual close determination of service conditions for the information of

competing manufacturers; but the pumps were completely designed—lock, stock and barrel—in the board's offices and from an intimate experience with the behavior of other pumps under the peculiar local conditions.

The performance of the old centrifugal units (the design and installation of which followed ordinary standard practice) was far from satisfactory, and it is debatable whether the desired improvements could have been secured at all without some development of a different type machine—and perhaps of a more neglected one like the screw pump. For instance, the suction lifts under early storm conditions generally decreased and the centrifugals automatically became overloaded, decreasing in efficiency and increasing in power draft beyond the possibilities of an economical supply. Inspection and cleaning of the pumps in their pits were possible only at intervals and under some little difficulties. The synchronous motors had to be started under load, and this necessitated the telephonic feat of slowing down distant engines and bringing generators and motors up to speed in synchronism. Expensive check gates were required for guarding against backflow. How all these adverse conditions were removed by designing the new pump propellers for use in an inverted-siphon elbow is most interestingly told by Mr. Earl elsewhere in this issue.

The new units draw maximum power only at maximum lift; and at minimum lift they pump five times the quantity of water per horsepower that the old centrifugals did. The pumps are accessible for continuous inspection; the synchronous motors can be started light and the load thrown on gradually by priming. No check gates are required. All this in itself was a noteworthy accomplishment, the rewards of which there is good reason to doubt would not have been secured in quite such measure had the board not had as its own designers the engineers on whom the old trials had borne hardest. That the designers' liberal estimate of efficiency, 70%, was exceeded by 10% and held high over a wide range is no less to the credit of the designers—though the makers share in this credit. If the New Orleans work cost a little more than it could have been farmed out for, as it probably did, the results more than justify the board's insistence on this particular procedure.

Why Not an Eight-Hour Law for Steamboat Inspectors?

A few years ago Congress passed a stringent law limiting the number of hours in a day which railway corporations may permit their trainmen to work. The Interstate Commerce Commission, which is charged with the enforcement of this law, last year prosecuted 125 cases against railway companies for infractions of the law. The reason assigned for the enactment and enforcement of the law is the securing of safety in railway service, and there is little dissent from the proposition that the requirements of the law are on the whole reasonable.

But Congress does not observe in the Government service the standards it compels railway corporations to observe in the conduct of their business. The men whom the Government employs to inspect steamboats and see that safety is observed are surely as essential to the safety of travel by water as is the work of trainmen to travel by rail. Secretary Redfield of the Department of Commerce and Labor declares that the Government employees in the Steamboat Inspection Service are seriously overworked. In his annual report to Congress a year ago he said:

> It is useless to pass more exacting laws [for the inspection of vessels] until Congress shall have given the Steamboat Inspection Service enough men to enforce the laws that already exist. In some districts men are required to work from five o'clock in the morning until ten or eleven o'clock at night. . . . It should not be necessary for a great disaster to occur before the necessary steps are taken to prevent further disaster.

In his annual report just presented, Secretary Redfield says that Congress has paid little heed to his appeal and that the overstrain went on and still continues. Besides the duties previously required of the Steamboat Inspection Service, the new seamen's law imposed fifteen or more additional duties upon it and made no provision for additions to the force. More than this, the "great disaster," of which Secretary Redfield a year ago suggested the possibility, has occurred. The "Eastland" catastrophe might have been averted had there been a competent board of naval architects in the Steamboat Inspection Service with authority to inspect the hulls of vessels, a recommendation made in previous reports by the department.

There have been many statements published reflecting on the Steamboat Inspection Service as inefficient in connection with the "Eastland" disaster and other matters. Secretary Redfield's report puts the responsibility squarely upon Congress. Secretary Redfield is not alone a Cabinet officer, whose position entitles him to speak with authority, but he is a business man of long experience accustomed to deal with labor questions, and his opinion should carry great weight. It is surely time that the Federal laws concerning the safety of travel by water were revised to suit present-day conditions, and an organization sufficient for their enforcement should be created.

Complete the Geodetic Survey of the United States

Every engineer appreciates that accurately located triangulation points and benchmarks are the first essential for accurate mapping in all classes of engineering work. As is pretty well known, the United States Coast and Geodetic Survey, besides its hydrographic surveys of the coast, has done a considerable amount of work on the extension of a network of primary triangulation over the United States. It has also done much work on a precise-level network covering the entire country.

In the annual report just issued, E. Lester Jones, superintendent of the survey, urges that this work should be carried to completion at an early date instead of being allowed to drag along for an indefinite time. When the work now planned is completed, there will be no place in the United States distant more than 100 mi. from a primary triangulation station and a precise-level benchmark. To complete the geodetic work necessary to accomplish this will cost only about $1,250,000. When this work is done and properly monumented, the results will be perpetually available.

The Federal Government alone is spending several million dollars annually for surveys and maps of various kinds. There are frequent demands upon the Coast and

Geodetic Survey already from cities which ask to have triangulation points and benchmarks established, on the basis of which city surveys can be carried on. The Survey has been unable to respond to some of these requests, on account of lack of funds.

The argument has been repeatedly brought forward in Congress that the surveys in the interior of the country should be carried on by the states themselves. There was for a long time much prejudice against the extension of the coast-survey triangulation to cover the interior of the country. Every engineer, however, can readily understand the impracticability of having each of the 48 states conduct its own system of triangulation inside its own boundaries without the aid of a primary triangulation network covering the entire continent on which to base the work.

There has been at times severe criticism of some of the surveys carried on by the Federal Government, on the ground of their inaccuracy. No such criticism has ever been made of the work done by the Coast and Geodetic Survey. Its work is fundamental to all surveying and leveling done throughout the country, since every class of civil-engineering work, and in a sense every engineer, is dependent on accurate mapping. There will be unanimous agreement among engineers that the accurate foundation work necessary for such mapping ought to be completed by the Coast and Geodetic Survey, and Congress should furnish the funds as rapidly as the work can be carried on.

Letters to the Editor

What Causes Rumbling Noise from Brick Pavements?

Sir—The writer has seen many theories as to the cause of rumbling from cement-grouted brick paving, and he has observed the phenomenon under circumstances which do not fit any of the theories. He has made some further observations that promise a theory to better fit the case.

A close examination of brick pavements laid without transverse joints reveals cracks transverse to the street and usually about 10 ft. apart. These cracks may be and usually are very fine; but they are plainly visible when the street surface is clean, as for instance after washing or after a shower.

The rumble occurs when a steel-tired wheel at speed crosses a crack. Each wheel causes a rumble, which accounts for the continuance of the noise. In all the pavements on which I have observed the phenomenon, the brick had been cement filled to form a continuous sheet from end to end of the block. Expansion joints had been laid next to the curb along both sides of the street and were in excellent order. I have not yet observed a resonant pavement in which the cracking was general, or one laid with any save cement filling.

The writer has diligently sought and has so far discovered no case of a rumble except as above stated. He would be glad to hear of either confirmation of his conclusion or definite evidence of a rumble which does not occur at a crack, as above stated. H. K. HIGGINS.

209 McBride St., Jackson, Mich., Dec. 20, 1915.

Illustrating the Necessity of a National Drainage Law

Sir—The present status of development of the Bristol Drainage District in Wisconsin admirably illustrates the crying need for a national law under which interstate drainage projects may be organized.

The whole situation summed up in as few words as possible is this: The land in the south central part of Kenosha County, Wisconsin, slopes wholly to the south. The available fall, for drainage, of all the land from the state line of Illinois north into this state is very slight and in fact is not great enough to construct a successful drainage ditch with a proper outlet. But by building a ditch south into Illinois a distance of about 2½ mi., all the waste marshy land of Kenosha County can be reclaimed.

I recommended this plan and designed a drainage system accordingly. On Oct. 27 bids were taken. The following day the commissioners of the drainage district consulted attorneys other than the attorney who had guided and in fact fostered the whole undertaking.

The result was a wide difference of legal opinion as to whether the drainage commission appointed under the laws of the State of Wisconsin had authority to assess land in Wisconsin to pay for construction in Illinois. One lawyer held the opinion that the commissioner who let contracts for work in another state would be personally liable for the cost of construction done outside the jurisdiction of the state laws under which he was appointed. On receiving this opinion the commissioners returned all bids; but they are anxious to go ahead with the work, if assured that they are vested with the proper authority.

At present there is $115,000 worth of work held back just because this legal technicality has never been decided in the United States Supreme Court. The total cost of construction was to be paid by Wisconsin land owners. It seems to me that, bearing this in mind, if the courts held that the interstate drain could not be accomplished by following the laws of one particular state, then Congress should enact a Federal drainage law that will make interstate projects possible.

Reclaiming land by drainage accomplishes the same results as irrigation. Irrigation is a national question and has been ably handled as such. Cases of interstate drainage constantly arise throughout the Middle West. In looking up this case, five others were discovered which were identical with the situation here.

The United States Department of Agriculture advocates putting all available land under cultivation; yet in this one locality there are thousands of acres, which the Wisconsin Agricultural Department reports rich in productive soil, going to waste for the want of an adequate drainage law. WILLIAM E. O'BRIEN,

Kenosha, Wis., Dec. 24, 1915. Civil Engineer.

Peculiar Failure of a Grouted Brick Pavement

Sir—In your issue of Nov. 18, 1915, there is a letter by Samuel Whinery relative to the merits of sand-and-cement and mortar beds for brick pavements. We have had a peculiar experience with a grouted brick pavement laid on a dry sand-and-cement cushion buckling between rails of a street-car track. The sand and cement were mixed dry, the brick laid and rolled, then the whole was well wet with a hose to moisten the sand and cement mixture before the joints were grouted.

The buckling occurred several weeks after the pavement was finished, and the weather has been continuously colder since that time.

I should like to know if any of the readers of *Engineering News* can give information or experience as to the cause or causes of a condition of this kind.

The pavement outside of the rails was laid on an ordinary sand cushion and so far has shown no signs of buckling. Expansion joints were placed every 50 ft. in the paving between the rails. I might add that the pavement was laid on a 6-in. 1:3:6 concrete base with an additional 6 in. under the ties; 70-lb. rails were used in the track and a 3-in. special brick was laid between the rails.

F. T. GILLETT,
Engineer Vincennes Traction Co.

Vincennes, Ind., Dec. 20, 1915.

Calcium Chloride for Gravel Road Maintenance

Sir—It may be of interest in connection with the article in *Engineering News*, Dec. 9, 1915, on "Gravel Roads of New Hampshire," to note the two years' successful experience of the Connecticut State Highway Department in the use of calcium chloride for maintaining gravel roads.

We have a theory that this material should be used only on roads built of gravel and located near watercourses or large bodies of water, in order that the amount of water in the atmosphere may be as great as possible.

We have not had very much experience with the use of calcium chloride on waterbound macadam roads built with trap rock; and my impression is that the material in these roads is so hard and close-grained as to preclude the containing of water in the voids, either in or between the stone, so that we have not used calcium chloride for roads of this character.

There is a further benefit from the use of this material in that successive treatments do not injure the surface of the road or change its character, as is the case when oil is used more than three or four times.

The calcium chloride is applied to the surface of the road from a fertilizer spreader when the road is slightly moist. The moisture in the road and in the atmosphere causes the material to gradually change its appearance and form a moist mat over the surface of the road.

Five miles of different roads in the town of Middlebury was treated with calcium chloride in 1914-1915 at a cost of $1,844.29, which makes the actual cost (including patching) $368 per mi. The cost is divided as follows: Material, $1,301.49; labor, $381.74; labor (patching), $161.06; total, $1,844.29.

These roads are treated for about 14 ft. in width, and the treatment gradually extends of itself to the total width between shoulders, which is about 22 ft. The cost given we consider the maximum for roads of this type; that is, the cost will vary from $300 to $370 per mile for the calcium-chloride treatment alone.

C. J. BENNETT,
State Highway Commissioner.

Hartford, Conn., Dec. 24, 1915.

[The experimental use of calcium chloride on some of the New Hampshire gravel roads should have been referred to in the article mentioned. However, it has not been used to any extent in New Hampshire, the editor was informed, because of the added expense and because results during the past year have been highly satisfactory without its use; but in an exceptionally dry season it is very probable that the use of calcium chloride would materially assist in keeping gravel roads in a moist and dragable condition. Adding the cost of calcium-chloride treatment based on the Connecticut experience to the cost of patrol maintenance as now practiced in New Hampshire would bring the total cost of gravel-road maintenance, under adverse conditions, to between $600 and $900 per mi. per year.—Editor.]

Youngstown's Hot Bolt

Sir—P. Justus, of Cleveland, is probably correct in his letter published Dec. 30, 1915, in regard to stray currents in the Market St. bridge in Youngstown. The writer has come to the same conclusion and may add some interesting facts. The bolt in question is cold on Sundays and holidays when the building is not in use. Stray currents *from the building* seem to be the cause. Question for an electrical engineer: Will these currents cause corrosion in some part of the structure? If an eventual failure cannot be discovered in time, who is at fault—the city authorities or the Republic Iron and Steel Co.?

I. OESTERBLOM.

Youngstown, Ohio, Dec. 31, 1915.

Not Crystallization but Bad Maintenance the Trouble

Sir—I was glad to see your editorial on the failure of the Division St. bridge, of this place. "Granulation," "fatigue," "crystallization" and the acts of the Lord in general furnish a good quantity of whitewash for city officials who fail to perform their duty.

Had the Division St. bridge been cared for in 1894, during the high water, with more brains and less dynamite, and had less politics been applied to its maintenance since, it no doubt would be standing today instead of being as it now is in the bottom of the Spokane River.

Spokane, Wash., Jan. 5, 1916. H. MILLER.

Government Manufacture of Armor Plate and of projectiles is recommended by Secretary Daniels in his annual report. In 1900 Congress passed an act authorizing the Secretary of the Navy in his discretion to build an armor-plate factory. The committee at that time reported that a Government plant could manufacture armor at a cost of $263 per ton, with an output of 10,000 tons per annum. Since that recommendation was made the Government has paid over $76,000,000 for armor to private firms. The Secretary also recommends that the Government should manufacture a large proportion of the smokeless powder that it uses and should more actively employ its navy yards in shipbuilding.

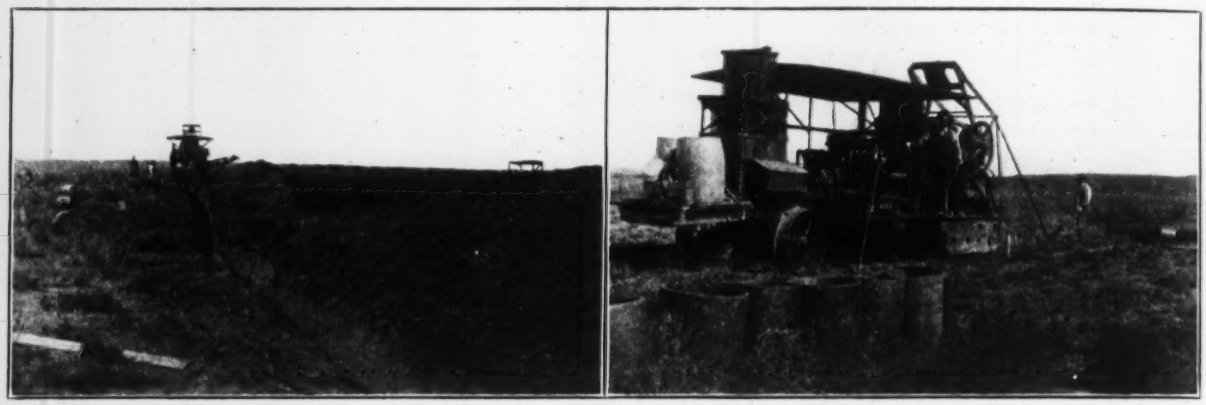
Tile-Drainage Systems for Irrigated Land

The construction of drainage systems in land which is to be irrigated is being carried out in the Pecos Valley in the neighborhood of Roswell, N. M. This work is made necessary by the presence of alkaline salts in the soil and the peculiar condition of a fluctuating level of ground water. Under the influence of irrigation without drainage, the salts tend to work to the surface and spoil the land, while excess water may make the land too wet for agricultural use.

Drainage works for four large districts are now under construction: (1) Roswell district, east of Roswell, 12,000 acres; 100 mi. of drains; cost, $200,000. (2) Dexter-Greenfield district, 18 mi. southeast of Roswell, 19,000 acres; 145 mi. of drains; cost, $325,000. (3) Hagerman district, 7,500 acres; 65 mi. of drains; cost, $134,250. (4) East Grand Plains district, 8 mi. southeast of Roswell, 8,000 acres; 60 mi. of drains; cost, $84,000. The four districts aggregate 46,500 acres, with 370 mi. of drains and an estimated total cost of $743,250 for drainage. Work was begun in September, 1915, and will be completed in about two years. The first three are complete drainage systems. The fourth is an outlet system giving an outlet for every 40 acres.

The topography is fairly level, with a general eastward slope of 20 ft. per mi. The soil is colluvial and alluvial and very productive under a combination of irrigation and tile drainage. It is hard and dry where irrigation has not been started. In some places irrigation had been applied without provision for drainage, and here the water had converted the soil into a sticky gumbo which became almost a slushy mud where water was in excess.

The main drains are located in the draws, or natural hollows, with the lateral drains coming in at intervals of 500 to 1,500 ft. The minimum depth of the drains is about 6 ft. to the top of the tile. Owing to the high percentage of alkali in the soil, all the drains are of hard-burned vitrified salt-glazed tile. The tiles are 6 to 30 in. in diameter. They are laid with butt joints, each joint being covered with tar paper. Through the rows of cottonwood, willow and other water-seeking trees, sewer pipes with bell ends and cemented joints are used in order to prevent the roots of the trees from entering and obstructing the drains in the course of time.



FIGS. 1 AND 2. TRENCHING MACHINES WORKING IN DRY HARD SOIL IN THE PECOS VALLEY; LAND NOT YET PLACED UNDER IRRIGATION

Fig. 1—Trench made by machine. Fig. 2—Near view of machine

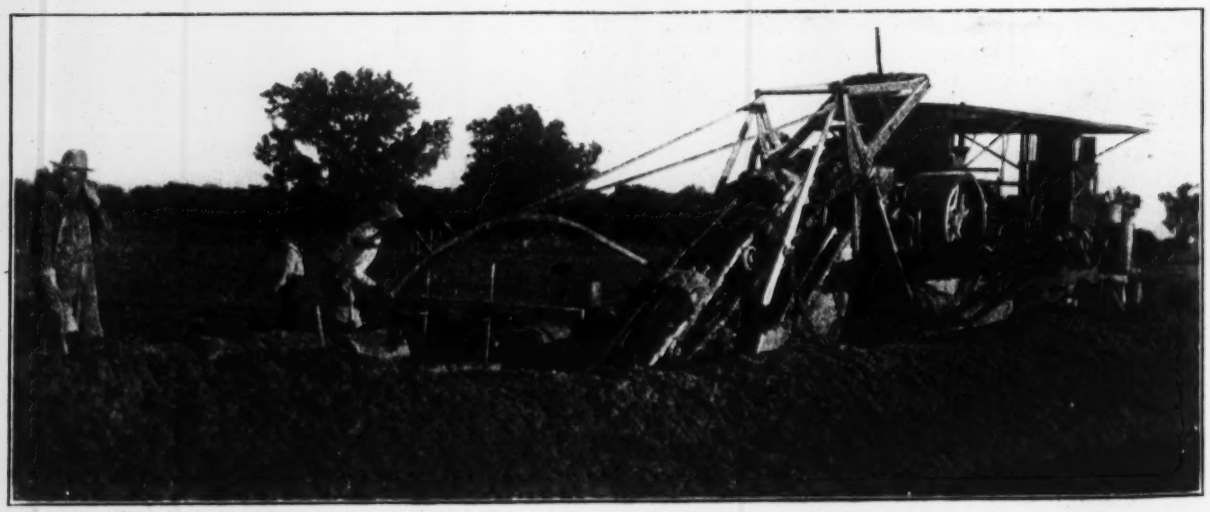


FIG. 3. TRENCHING MACHINE WORKING IN LAND MADE WET BY IRRIGATION; NO PROVISION FOR REMOVING WATER EXCEPT BY EVAPORATION

The tile is hauled and distributed along the lines of trains by wagon and teams, the average haul being 3 mi. for the Roswell and East Grand Plains districts and 1½ mi. for the others. The hauling is done by contract.

The trenching is being done by Austin gasoline trenching machines exclusively, each machine being followed by an Austin backfiller to refill the trench. The average speed of each trenching machine at depths varying from a minimum of 6 ft. to a maximum of 9 ft. is 1,000 lin.ft. per day of 9 hr. One man operates the machine, and the cost of operation is approximately $11 per day, including repairs. The backfillers are self-propelling, and each has a boom and cable attached to a scraper. One man runs the machine, and another man handles the scraper. Before these backfillers were in use, the work was done with horses and slip scrapers.

The condition of the soil varies as mentioned above. Fig. 1 shows the trenching machines at work in the dry hard soil, cutting a 10-in. trench 9 ft. deep at the rate of 2 lin.ft. per min. Fig. 2 shows the machines working in sticky gumbo and soupy clay, the effect of irrigation water that at present can escape only by evaporation. The water stands in the bottom of the trenches.

The tiles of larger sizes are lowered into the trench by means of block and tackle hitched to a tripod frame. Those of the smaller sizes are handled by a rope and a pipe-laying hook. The lines and grades are set out by the engineers. The manholes and outlets are of corrugated ingot-iron pipe. In the first three districts there will be 2,995 manholes, spaced about 500 ft. apart.

The engineer for the Roswell, Dexter-Greenfield and Hagerman districts is H. W. Vauchelet, of Roswell, N. M., to whom we are indebted for information. The contract for these three districts was let to W. S. Dickey, of the W. S. Dickey Clay Manufacturing Co., of Kansas City, Mo., which company furnishes the pipe. The construction work is being done by the Lana Construction Co., of Council Bluffs, Iowa. The engineer for the East Grand Plains district is W. A. Wilson, of Roswell, N. M.; the Bullock Co., of Kansas City, Mo., has the contract for this district.

Testing Water-Works Mains at Hartford, Conn.*

By Caleb Mills Saville†

Tests of about two miles of 8- to 20-in. cast-iron water mains recently added to the water-works of Hartford, Conn., are summarized in the accompanying table. The pipe was laid in city streets by the regular maintenance force of the department.

On the basis of nominal diameters the leakage from this line under test pressures varying from 100 to 125 lb. per sq.in. was at an average rate of 0.695 gal. per 24 hr. per lin.ft. of pipe joint, or 87.9 gal. per 24 hr. per in.-mi. of pipe.

In the tabulation, results are given in terms of linear feet of pipe joint, as the linear foot seems to be the most logical unit. Nominally, pipe joints are 12 ft. apart; practically they are seldom or never this distance. On the section of distribution pipe given in the table the laying length has varied from 10.8 to 12 ft. If there are many specials or cut pipe, the laying length may be reduced considerably below that given. As the unit—"inch diameter per mile of pipe"—must be deduced from the length of pipe joints actually exposed to leakage, the actual number of joints makes considerable difference in the result. Besides this, in almost every line there are branches and connections having various-sized joints differing from those on the main line. These must be considered in getting a unit for expressing leakage. All of these conditions readily fall in with "leakage per linear foot of joint," and for this reason that unit is considered to be well adapted for the purpose of comparing leakage for different pipe lines.

In running these tests sections between gates are ordinarily taken. The intention is to apply about 40 lb. more pressure to the section under test than will ordinarily be expected. Wherever possible the section is subjected to several different pressure heads during the test, with the intention of obtaining data as to the character of the leakage. While the information is not yet complete, the indication is that with no gates or corporation cocks open or joints blown out the loss of water varies nearly directly with the pressure. With this supposition in mind it is possible to make very reliable deductions as to the kind of leak to look for when an expressive draft is shown in the test.

DATA FROM TESTS OF NEW WATER MAINS FOR LEAKAGE, AT HARTFORD, CONN.

Diam., In.	Length, Ft.	Joints on Main Pipe No.	Joints on Main Pipe Lin. Ft.	Test Pressure, Lb. per Sq.In.	Leakage per 24 Hr. Gal. Total	Leakage per 24 Hr. Gal. Lin. Ft. of Joint
10	620	54	149a	126	140	0.947
20	2,325	194	1,017	93	130	0.128
12	1,197	102	320	106	98	0.306
12	1,427	115	366b	110	432	1.0808
12	1,070	99	341c	125	5825	1.7068
8	1,159	101	224d	108	194	0.862
12	1,054	91	306e	125	97	0.314
8	550	50	114f	120	75	0.670
8	1,076	93	296g	120	3764	1.820
8	562	49	160h	105	162	1.485
	10,940 = 2.07 mi.		3,077	...	2,286	0.717

a Includes four 6-in. joints. b Includes ten 8-in. joints. c Includes four 8-in. and fourteen 6-in. joints. d Includes eight 6-in. joints. e Includes fifteen 6-in. joints. f Includes four 6-in. and two 4-in. joints. g Includes six 6-in. and two 4-in. joints. h Includes four 6-in. joints. i Ordinary pressure here is 65 lb. leakage at this pressure, 27 gal. per 24 hr. j Large amount probably due to corporation cocks not entirely closed. k Includes some leakage at an 8-in. connecting gate. l Includes some leakage from an 8-in. gate.

The apparatus used in testing is the ordinary force pump for clearing obstructions from service pipes. Usually the pump has been a single hand-operated force pump, 2 in. in diameter and of 4-in. stroke, operating from a small tub. The capacity of this pump under 100 lb. pressure has been found to be about 2 gal. per min. The quantity passing the pump is measured by an ordinary meter of small size. The cost of testing, including all labor, material and supervision, has averaged about $6 per test.

*From a paper read before the New England Water-Works Association, Dec. 8, 1915.

†Chief Engineer, Board of Water Commissioners, Hartford, Conn.

The Towing Locomotives on the Panama Canal were adopted for handling ships through the locks to reduce the risk that vessels moving under their own power might collide with the lock gates. Especial care was taken in the design of the locks to guard against injury to the lock gates, heavy fender chains being hung in front of the gates to check the momentum of any vessel which might approach the gate too closely before stopping. The annual report of Capt. C. H. Rose, Superintendent of the Gatun locks, says that the ships' engines are used in starting and stopping vessels to relieve the locomotives of part of the strain and to save time. A few cases of errors or slowness by ships' engine-room forces in obeying signals have occurred, which have demonstrated the utility of having the separate towing system by towing locomotives. In all cases the locomotives have been able to stop the ship before it reached the suspended chains or the gates.

Charles Conrad Schneider

By Paul L. Wolfel*

C. C. Schneider, who died at his home in Philadelphia on Jan. 8, 1916, was born at Apolda, in the Duchy of Saxony, Germany, in the year 1843. At an early age he entered a machine shop, where he served an apprenticeship as a preliminary to his engineering education. In 1864 he graduated from the Royal School of Technology, at Chemnitz. After his graduation he spent a few years in his native land and came to this country in 1867. His first employment in his adopted land was at Paterson, N. J., where he served for about three years as designer at the Rogers Locomotive Works.

Mr. Schneider was quick to perceive the large field for development that lay in the branch of the profession that he subsequently adopted, and he chose it as the principal study of his life. His name will be prominently associated with those members of the profession who have done so much during the past forty years to study the science and perfect the art of structural engineering.

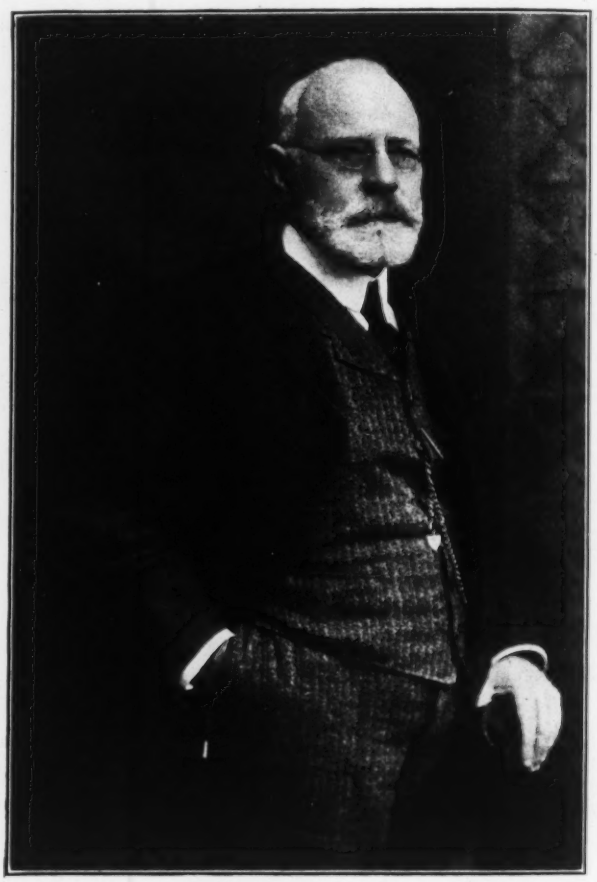
His first work in this line was with the Michigan Bridge and Construction Co., of Detroit, where he remained about three years. In 1873 he came to New York City, to take the position of Engineer-in-Charge of the engineer's office of the Erie Railroad Co., under Octave Chanute, Chief Engineer. While in the service of the Erie, one of his duties consisted in checking strain sheets and plans submitted by bridge companies. At that time this was not a general practice; railroads generally depended upon the bridge companies for the correctness of their designs. Another duty consisted in instructing inspectors. At that time experienced inspectors could not be obtained and work was generally accepted without inspection. For this reason young men employed in the office, who showed some practical ability, were selected for that purpose, and taken to some of the shops where work was in progress and given practical instruction.

The year 1873 may therefore be considered as the period at which systematic bridge inspection was commenced. The bridges which were contracted for in 1873 were let on the competitive lump-sum basis, which was then the usual practice. This, however, did not prove very satisfactory, as each bridge company at that time had its own type of truss. It was concluded that the only way to obtain a reasonable uniformity in all bridges was to have the plans prepared by the engineers of the railroad and Mr. Schneider was given that duty.

In 1874 the bridges which were needed during that year were designed by the railroad company's engineers and the work let on a pound-price basis. This was probably the first instance where bridgework was let by the pound.

In 1876 he was engaged with the Board of Engineers appointed by the Long Island Bridge Co. to pass upon competitive plans for a railroad and highway bridge across the East River, to connect Long Island with New York City. It was the intention to locate this bridge between 76th and 77th St., the location being selected as the narrowest point in the East River, requiring spans of only 734 ft. across the west channel and 618 ft. across the east channel. The project, however, was not carried out at the time on account of the financial embarrassment of the company. After this work was finished he was engaged by the Delaware Bridge Co. as a designer.

In 1877 Mr. Schneider opened an office as consulting engineer in New York City and for several years was engaged in connection with various important enterprises of that period. In 1879-1883 he was associated with the late George S. Morison on the Plattsmouth, Bismarck, Blair and Rulo bridges across the Missouri River and the Snake River bridge at Ainsworth, Wash. In the years 1882 and 1883 he designed the cantilever bridge over the Fraser River for the Canadian Pacific Ry. and the Niagara River cantilever for the Michigan Central R.R. These two bridges stand among the first of the modern type of cantilever. Mr. Schneider's name will always be associated with the development of this type of structure.



C. C Schneider

Many other important works were of his design, notably the extensive wooden viaduct at Marent Gulch on the Northern Pacific and the Stony Creek viaduct on the Canadian Pacific Ry. He also designed the anchorage for the Statue of Liberty in New York Harbor. In 1886 he was awarded the first prize for the design of a bridge over the Harlem River at New York, intended for the site of the present Washington arch bridge.

In 1886 the A. & P. Roberts Co., of the Pencoyd Iron Works, Philadelphia, added a bridge and construction department to its iron-manufacturing plant, and Mr. Schneider became associated with these works in that year

*Chief Engineer, McClintic-Marshall Co., Pittsburgh, Penn.

as Chief Engineer. The works developed very rapidly and within twelve years from their origin had a productive capacity of 8,000 tons per month, which largely exceeded the output of any bridge shops elsewhere.

In 1893 the Long Island Railroad Co. took an interest in the project of a bridge over the East River at Blackwell's Island, previously referred to, with a view of establishing a terminal in New York City. Work was actually commenced, and competitive designs for the bridge were invited in 1894. The bridge was to accommodate four railroad tracks, with approaches and a terminal station west of Second Ave., New York City. The plans adopted by the Long Island & New York Bridge Co. were the designs of Mr. Schneider, for the Pencoyd Iron Works, to which company the contract for the entire steel superstructure of the bridge and approaches was awarded in March, 1895. Considerable work had been done on this bridge on piers and foundations, complete detail drawings of the superstructure made and a portion of the material rolled, when on account of the death of Austin Corbin, President of the Long Island R.R., the company again became disorganized.

In 1900, when the American Bridge Co. was formed, Mr. Schneider was elected Vice President, in charge of engineering, which position he held until 1904, when desiring to be relieved of some of the burden, he was retained by the company as Consulting Engineer, devoting a portion of his time to private practice. He remained with the company as Consulting Engineer up to the time of his death. During this time he was also employed by the Canadian Pacific Ry. as Consulting Engineer. After the collapse of the Quebec Bridge in 1907, he was called in by the Canadian Government and made a very exhaustive report on this matter in 1908. In 1911 he was appointed by the Canadian Government a member of the Board of Engineers for the building of the new Quebec Bridge, which position he retained until his death.

Mr. Schneider has been a frequent contributor to the proceedings of the engineering societies and to the technical journals. In 1886 he received the Rowland prize from the American Society of Civil Engineers for his paper on the Niagara cantilever bridge. He also received the Norman medal in 1905 for his paper on "The Structural Design of Buildings," and again, in 1908, for a paper on "Movable Bridges." These, together with his "Standard Specifications for Railway and Highway Bridges" and volume of "Standard Details" for the American Bridge Co., form a part of his contributions to technical literature.

When Mr. Schneider wrote his first specifications for the Pencoyd Iron Works, he for the first time put his impact theory to practical use. This method of figuring has been adopted by a large number of railways and also by the American Railway Engineering Association in their specifications.

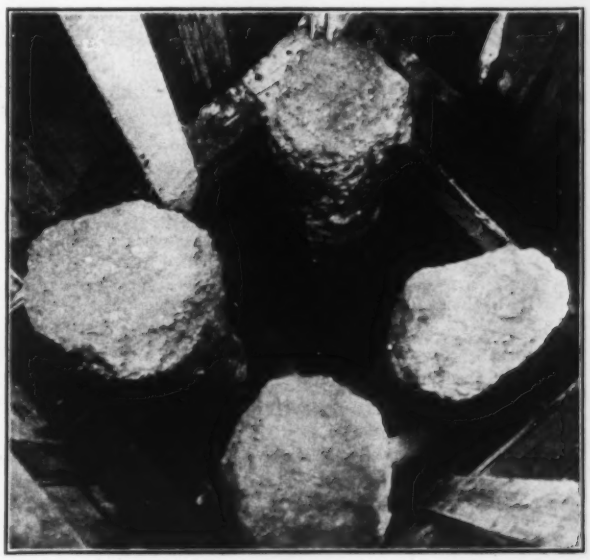
Mr. Schneider was a member of the American Society of Civil Engineers, American Railway Engineering Association, American Society for Testing Materials, the Verein Deutscher Ingenieure in Germany and the Engineers' Club in New York. He served as director in the American Society of Civil Engineers in 1887 and 1898 and was elected vice president in 1902 and president of the society in 1905.

He always stood out for good work, good designs and good details, and the present practice in bridge and structural work is greatly indebted to him for the high standard that has been obtained. He was most democratic in his ways and always ready to assist the young engineer by word and deed, and large indeed is the number of engineers today in responsible positions who owe these positions to his training and his advice. He was of a most lovable disposition and gained in the highest degree the respect of everybody who came in contact with him. His was a most useful life, well lived, an example and an inspiration to the profession that will live in the memory of all who had the privilege of knowing him.

Pedestal Pile Shafts Exposed for Test Observation

In connection with the foundation work for a new building of the American Druggists Syndicate at Long Island City, N. Y., a test of the integrity of the shafts of cast-in-place "pedestal" piles was carried out by the contractor, the MacArthur Concrete Pile and Foundation Co., at the request of John W. Moore, Superintendent of Buildings, Borough of Queens, New York City.

Four piles, spaced on the corners of a 3-ft. square, were driven with the standard pile-forming apparatus and following the standard methods of the company. Each pile was approximately 20 ft. long and was driven to a resistance of eight blows per inch, with a No. 2 Vulcan steam hammer. The piles were driven one after the other with no intervening interval, at the rate of 30 min. to the pile. The soil consists of a surface fill of the trash of an old dump, underlain by a thick marshy muck. The piles brought up on a sand stratum.



LOOKING DOWN PIT EXCAVATED AROUND FOUR "PEDESTAL" PILES

After the piles were all driven, the space was sheeted and the ground surrounding them excavated to a depth of 14 ft., or about 3 ft. above the top of the pedestal. As shown in the accompanying view, which is looking down the pit opened up around the piles, the pile shafts were all found to be of uniform section and apparently uniform density, indicating that the driving of one pile had not affected the section of the adjacent pile just driven.

News of the Engineering World

Progress of Ontario Municipal Railway Union

By-laws appropriating large sums of money for the construction of the first of the Ontario Hydro-Radial Ry. lines were passed by 16 municipalities on or about Jan. 1. Four towns rejected the ordinances and 11 have yet to vote. This interurban line runs from Toronto to London, Ont., by way of Guelph, Berlin, Stratford and St. Marys, and is intended to serve as a main line from which eventual branches will be built. The cost has been estimated by the Ontario Hydro-Electric Commission at $13,734,155. This commission will supervise the construction, equipment and operation of these lines in connection with its work of supplying power to provincial cities for their distribution.

The funds are to be raised by debentures issued by the municipalities in guarantee for their respective apportionments; these sums will be further guaranteed by the province. The principal amounts voted are: Toronto, $1,240,196; London, $1,109,303; Berlin, $774,040; Guelph, $731,862; and Stratford, $651,735.

Sir Adam Beck, chairman of the Hydro-Electric Power Commission, has stated that the first work would be on the routing of lines through the larger cities and that the first expenditures would be for rights-of-way which should be secured while the land is cheap. He intimated that construction was likely to be deferred until the close of the European War, on account of the high price of materials. The power supply needed for the railway and for increasing demands on the commission's lines would be secured by a 600,000-hp. development at Niagara Falls. The commission at present handles about 120,000 hp.

Supreme Court Settles Oregon State Highway Controversy

The Oregon State Highway Department controversy, as to whether the state engineer or the first deputy state engineer was in charge of the highway department, has been settled by the State Supreme Court after six months' litigation. The last legislature consolidated the state highway department with the office of the state engineer, with a provision that the highway work should be in charge of a first deputy engineer, appointed by the governor.

The dispute as to who should have control of the highway department began soon after the law went into effect last May. A decision as to who was legally state highway engineer was forced by the contracting firm of Peterson & Johnson, who refused to accept the first deputy's estimate of work done by them and applied for a writ of mandamus in the Supreme Court to compel the state engineer to supply the estimate.

In allowing the application for the writ the court ruled that the provision of the consolidation law which placed the highway work in charge of a chief deputy engineer was invalid. The court held that this provision conflicted with the title of the act "for consolidating the two departments." The decision does not remove the right of the governor to appoint the chief deputy engineer, but the appointment of the deputy's subordinates is declared to belong to the state engineer and not to the deputy, as has been the practice hitherto.

Collapse of Bridge at Spokane Not Yet Explained

Since the fall of the Division St. bridge, Spokane, Wash., on Dec. 18, no facts as to the cause of the failure have come to light. A board of engineers reported shortly after the accident that the lower-chord eye-bars in the end panel of one truss broke from "granulation." The finding of a coroner's jury which inquired into the cause of death of the five victims did not deal with the cause of the bridge failure.

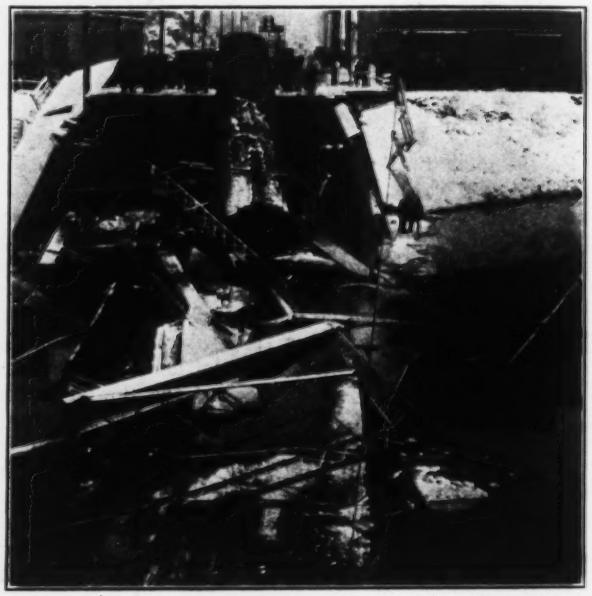


FIG. 1. THE DIVISION ST. BRIDGE AFTER COLLAPSE. LOOKING NORTH

The original design sheet, giving loads, stresses and make-up of members, is presented in copy herewith (Fig. 2). The illustration includes some notes as to added load, part of which was two 30-in. water mains and an 8-in. main. In the autumn of 1915 the old deck was replaced by a pavement of 4-in. creosoted wood block resting on 4-in. plank laid crosswise. The resulting total dead-load is estimated by Spokane engineers as 5,200 lb. per lin.ft. of bridge, as against 2,800 lb. provided in the design.

Vibration had proved troublesome in late years, due in part at least to automobile and motor-truck traffic and to increasing general vehicle traffic. This condition ne-

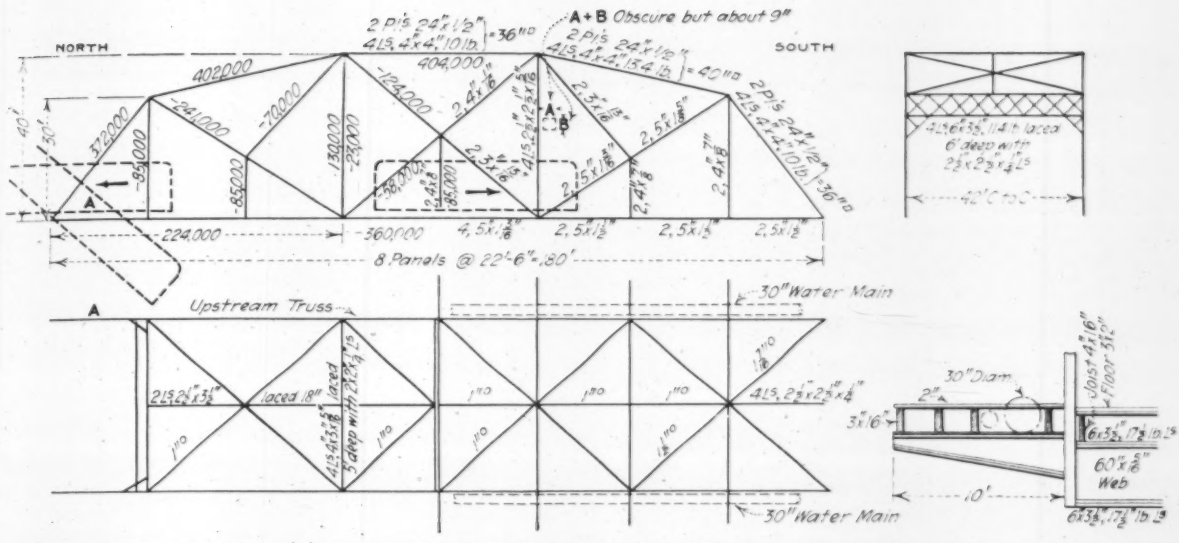


FIG. 2. COPY OF ORIGINAL "STRESS SHEET AND SECTIONS" MADE FOR DIVISION ST. BRIDGE
Some memoranda on recent changes are superimposed on the old matter. Floorbeam sketch added later

cessitated the replacement in 1914 of the old lower lateral system (adjustable rods) by a more rigid system of angles.

Damage suits for amounts totaling nearly $500,000 have been filed against the city. Pending the trial of these suits, the city authorities are not discussing the case publicly. However, City Engineer Morton Macartney is planning to have complete chemical and physical tests made of material from the bridge, as soon as all the wreckage has been recovered from the river bed. This work was delayed by cold weather but will probably be completed this week.

The city has several bridges over 20 yr. old. Though they are not overstressed, yet the city engineer has recommended that they be examined by bridge engineers and the desirability of replacing them considered, in view of the great increase in weight and amount of traffic.

FIG. 3. THE BROKEN EYEBARS AT THE NORTH END OF THE DIVISION ST. BRIDGE, SPOKANE, WASH.

Old Erie Canal Dam Fails at Tonawanda, N. Y.

A dam in the city of Tonawanda, N. Y., built in 1824 at the time of the original construction of the Erie Canal, failed on Jan. 7. The dam is a low structure built across Tonawanda Creek about half a mile above its mouth, where it empties into the Niagara River. Just above the dam the Erie Canal enters Tonawanda Creek and follows it for about 10 mi. eastward to Pendleton. The dam was built across the creek to raise the level of the water 6 to 7 ft. above that of the Niagara River. The dam itself is a wooden structure, but is flanked by masonry abutments at each bank. The level of the water above the dam is controlled by 12 flood gates at the north end of the dam and separated from it by a stone pier. While the wooden parts of the dam have of course been renewed from time to time, the masonry parts date back to the original construction of the canal. As the result of a recent thaw, the level of Tonawanda Creek was raised about 3 ft.; and although the 12 flood gates were wide open, a large volume of water was discharged over the dam. On the morning of Jan. 7 the masonry pier between the flood gates and the dam crumbled, and six of the flood gates collapsed at the same time. Shortly afterward about a third of the dam was carried out. The wreckage lodged against the piers of a bridge of the New York Central R.R., which crosses Tonawanda Creek a short distance below. A wrecking force was promptly brought to the spot, and the débris was removed before further damage was done. What will be done regarding the rebuilding of the dam is undecided, as it is not yet determined by what route the new barge canal will join the Niagara River.

*

A Drift-Wood Catcher has been built on the White River in Washington to prevent the log jams which sometimes cause water to back up and flood adjacent farm lands. It consists of a row of 26 concrete blocks rectangular in plan but set diagonally to the line of flow. Heavy eye-bolts project from the two upstream faces of each block, and to these are attached lengths of 1-in. steel cable. Three spacing bars divide each span into four panels, with diagonals in each to make the nine lines of cable in each length of "fence" act as a unit. The barrier, or catcher, was designed by W. J. Roberts as engineer for King and Pierce counties jointly. There is 18,000 ft. of this cable, supplied by the Broderick & Bascom Rope Co., of St. Louis, Mo.

The Railway Brotherhoods of conductors, engineers, firemen and trainmen are now taking a general ballot on the proposal that a demand shall be made upon the railway companies to establish a universal eight-hour day for all employees engaged in train service, at wages the same as those now paid, with time and a half for all overtime. The members are also voting on authorization of the heads of the brotherhoods to call a general strike of all the members in case the demand is not granted. Inasmuch as the necessities of train service compel a large proportion of train employees to work days considerably longer than eight hours, the movement is substantially a demand for a very large increase in the rate of railway wages. It is probable that few railway companies will feel financially able to grant this, and there is reason to believe that the demands of the railway employees when made will be reinforced by a general strike.

Largest Building in St. Paul Completed—The Railroad and Bank Building, St. Paul, Minn., is completed. It is now 14 stories high, but its foundations are designed for four additional stories. The ground plan is 290x232 ft., with an inner court 110x140 ft. The total floor space is 934,000 sq.ft. The building will house the general offices of the Great Northern and Northern Pacific railroads, the Northwest office of the Chicago, Burlington & Quincy and two banks. The Great Northern and the Burlington will use about half the total floor space, the Northern Pacific 400,000 sq.ft.

The building has a steel frame and concrete floor slabs, with marble, brick and terra cotta finish. The work of razing the buildings on the site began in February, 1914, and the new building was occupied on Dec. 1, 1915. The estimated cost was $4,000,000. The architect was Charles S. Frost, Chicago; the consulting engineer, the Toltz Engineering Co., St. Paul; the builder Grant Smith, St. Paul. An interesting feature is the cottage of bungalow style on the roof, 40x40 ft., with a living room, or restroom, 40x24 ft., and two bedrooms, in which directors' meetings will be held and directors from out of town may lodge.

The New Administration at Philadelphia has reappointed Carleton E. Davis Chief of the Bureau of Water. This is the more notable because the recent administration of the Department of Public Works under Morris L. Cooke was freely criticized for appointing outside experts to head the various bureaus. Mr. Davis was formerly Department Engineer of the Board of Water-Supply, City of New York.

PERSONALS

Messrs. Ezekiel C. Sargent, City Engineer, and Moses L. Brown, Commissioner of Public Works, of Quincy, Mass., have resigned.

Mr. Arthur W. Kreinheder has been selected by the new City Commission of Buffalo, of which he is a member, to head the Department of Public Works.

Mr. John J. Bracken, of Orange, N. J., has been appointed Town Engineer of Harrison, N. J., to succeed the firm of Borrie & Kreiner, which has done the town engineering work for many years.

Mr. Arthur S. Blaser, formerly with the W. I. Watson Engineering Co., has been appointed Chief Engineer for the Street Railway Commissioner of Cleveland, Ohio, at an annual salary of $3,600.

Mr. Chester E. Albright has been appointed Chief of the Bureau of Surveys, City of Philadelphia, to succeed Mr. George S. Webster, M. Am. Soc. C. E., recently appointed Director of the Department of Wharves, Docks and Ferries.

Mr. Sidney B. Williamson, M. Am. Soc. C. E., Chief of Construction in the United States Reclamation Service, with headquarters at Denver, Colo., has resigned to take charge of construction work in Chile. His resignation has been accepted and will take effect Mar. 1.

Mr. Raymond Shelby, formerly Assistant Engineer in Charge of Construction on the Glens Falls Feeder of the New York State Barge Canal, has accepted a position with the Standard Oil Co. of New York. He will be located at Batavia, Island of Java, in the East Indies.

Mr. Robert Clark Wheeler, Assoc. M. Am. Soc. C. E., Assistant Engineer with George W. Fuller, Consulting Engineer, New York City, has been appointed City Engineer of Summit, N. J., to succeed Mr. Alexander Blair, Assoc. M. Am. Soc. C. E., who resigned, to take effect Jan. 1, 1916.

Messrs. C. M. Spofford, Guy C. Emerson and F. W. Hodgdon, M.'s Am. Soc. C. E., have been appointed consulting engineers on the construction of the great new dry dock to be constructed by the Board of Directors of the Port of Boston. Mr. Hodgdon is Chief Engineer of the board.

Mr. R. W. Kelley, President of the Virginia Portland Cement Co., Allentown, Penn., together with Michael Gavin, Vice President, and F. W. White, Treasurer, have retired from their respective offices in the company. Mr. Harry C. Trexler has been elected President, E. M. Young, Vice President, and Alonzo F. Walter, Treasurer, to succeed the previously named officers.

Dr. Elmer L. Corthell and Messrs. Henry C. Allen, Eugene E. Haskell, Ernest C. Moore and Joseph Ripley, M.'s Am. Soc. C. E., have been appointed members of the Board of Consulting Engineers of the State of New York in conformity with the provisions of the Barge Canal laws of 1903 and 1911. Mr. Ripley will devote his whole time to the work and will receive a salary of $7,000 a year. The other members will receive $60 per day while engaged on state work.

Maj. F. C. Boggs, Corps of Engineers, U. S. A., M. Am. Soc. C. E., for the past eight years General Purchasing Officer of the Isthmian Canal Commission and the Panama Canal, and Chief of the Washington office, will be assigned in the near future to duty in charge of river and harbor works in the neighborhood of Montgomery, Ala. He will be succeeded by Maj. Earl I. Brown, Corps of Engineers, U. S. A., M. Am. Soc. C. E., who has had charge of the work to be taken over by Major Boggs. Major Brown has recently made a trip to the Isthmus to familiarize himself with conditions there.

OBITUARY

William Edward McDonald, Treasurer of the Flynt Building and Construction Co., of Palmer, Mass., died Dec. 11.

Ole N. Trooien, of Brookings, S. D., died Dec. 21, 1915, at 35 years of age. His illness began with an attack of the "bends" in 1908 while employed as a civil engineer in the construction of the Pennsylvania R.R. Hudson River tunnels. Mr. Trooien's "Steam Engine Investigations" thesis, written at the University of Wisconsin in 1907, attracted considerable international attention and is now largely incorporated in prominent mechanical-engineering handbooks.

Col. Alexander W. Swanitz, Civil Engineer in charge of construction of the Alaska Central R.R., died at his home in Alameda, Calif., Dec. 21. He had returned from Alaska about a month ago and was stricken with dropsy on the day of his arrival home. He was born in 1851 near Olney, Ill., and was educated in the schools near his home and at the Karlsruhe Polytechnik in Berlin and the Ecole Polytechnique in Paris. In 1872 Colonel Swanitz was appointed to a position in the engineering corps of Egypt and constructed various forts below Assuan and the harbor works at Alexandria. Later he was City Engineer of Scheveport, La. In 1880 he was appointed Chief of Construction for the Chicago & Northwestern Ry.; he also had charge of the construction of the Charleston & Macon and the New Orleans & Western railroads. In 1902 he went to Seattle to take part in the promotion and construction of the Alaska Central R.R., now known as the Alaska Northern Ry.

Stephen Betts Whiting, one of the charter members of the American Society of Mechanical Engineers, Manager from 1880 to 1882, Vice President from 1882 to 1883, and for many years owner, with his partner Charles G. Wilcox, of the firm of Wilcox & Whiting, of Camden, N. J., died Dec. 23 at his home in Cambridge, Mass. He was born at Redding Ridge, Conn., Jan. 22, 1834, and attended the schools of his home town and New Haven, finishing his education at the New Haven Collegiate and Commercial Institute. At 15 years of age Mr. Whiting was apprenticed to the machinist trade and designed and constructed a miniature steam engine, and at the age of 17 designed and built an air pump. In 1855, at 21 years of age, he went to Urbana, Ohio, to take charge of the shops of the Urbana Machine Co., and two years later became Superintendent of the Illinois Iron Works, of Alton, Ill. After several years he returned to the East to take charge of the Kaighn's Point Iron Works, which concern he and his old schoolmate, Mr. Wilcox, afterward purchased and operated under the name of Wilcox & Whiting. This firm built and erected the superstructure of the Chestnut St. bridge over the Schuylkill River in Philadelphia, and the U. S. Monitor "Koka," one of the light-draft monitors designed by John Ericsson. In 1865 the partnership was dissolved and the iron works sold, on account of Mr. Wilcox's poor health. The same year Mr. Whiting went to Pottsville, Penn., as Superintendent of the Colliery Iron Works, and while in that position he designed the Whiting system of rope drive, hauling and hoisting machinery, which was first installed at the Lehigh & Wilkes-Barre planes at Solomon's Gap, Wilkes-Barre, Penn., and which was adopted by many prominent mining companies. In 1878 he entered the employ of the Philadelphia & Reading Coal and Iron Co. as Mechanical Engineer, and was afterward made Chief Engineer and then General Manager of the company. In 1888 he became General Manager of the Calumet & Hecla Mining Co., which position he held until 1901, when he retired from active life.

ENGINEERING SOCIETIES

COMING MEETINGS

ENGINEERS' SOCIETY OF PENNSYLVANIA.
Jan. 14. Annual meeting in Harrisburg. Secy., E. R. Dasher, 30 So. Front St., Harrisburg, Penn.

CENTRAL RAILWAY CLUB.
Jan. 14. Annual meeeting in Buffalo, N. Y. Secy., H. D. Vought, 95 Liberty St., New York City.

WESTERN PAVING BRICK MANUFACTURERS' ASSOCIATION.
Jan. 14-15. Annual meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Bldg., Kansas City, Mo.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS.
Jan. 17-19. Annual meeting at Billings, Mont. Secy., C. C. Widener, Bozeman, Mont.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 18. Annual meeting in Pittsburgh. Secy., E. K. Hiles 2511 Oliver Building, Pittsburgh, Penn.

KANSAS ENGINEERING SOCIETY.
Jan. 18-19. Annual meeting at Kansas State Agricultural College. Secy., C. A. Foster, Topeka, Kan.

AMERICAN WOOD-PRESERVERS' ASSOCIATION.
Jan. 18-20. Annual convention in Chicago. Secy., F. J. Angier, Mount Royal Station, Baltimore, Md.

THE FRANKLIN INSTITUTE.
Jan. 19. Annual meeting in Philadelphia. Secy., R. B. Owens, Philadelphia, Penn.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 19-20. Annual meeting in New York City. Secy., C. W. Hunt.

NATIONAL DRAINAGE CONGRESS.
Jan. 19-21. Annual meeting, Cairo, Ill. Vice-Pres., Edmund T. Perkins, First National Bank Building, Chicago, Ill.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Jan. 20-22. Annual convention in Minneapolis. Secy., Alvin E. Dodd, 140 West 42nd St., New York City.

ILLINOIS CHAPTER: AMERICAN WATER-WORKS ASSOCIATION.
Jan. 25-27. Annual meeting, University of Illinois, Urbana. Secy., Dr. Edward Bartow, Urbana, Ill.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.
Jan. 26-28. Annual meeting, University of Illinois, Urbana, Ill. Secy., E. E. R. Tratman, Wheaton, Ill.

WISCONSIN HIGHWAY COMMISSIONERS' ASSOCIATION.
Jan. 31. Annual meeting in Madison. Secy., G. H. Mainwaring, Gotham, Wis.

WISCONSIN ENGINEERING SOCIETY.
Feb. 2. Annual meeting, Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.
Feb. 2-5. Annual meeting in Indianapolis. Asst. Secy., W. F. King, Indianapolis, Ind.

INDIANA ENGINEERING SOCIETY.
Feb. 3-5. Annual meeting in Indianapolis. Secy., Charles Brossmann, 1616 Merchants Bank Bldg., Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Feb. 4. Mid-winter meeting in Chicago. Secy., E. B. Burritt, 8 W. 40th St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 8-9. Mid-winter meeting in New York City. Secy., F. L. Hutchinson, 29 W. 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Feb. 9-11. Annual meeting in Columbus. Secy., John Laylin, Norwalk, Ohio.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY.
Feb. 10-12. Annual meeting at St. Paul. Secy., Geo. H. Herrold, St. Paul, Minn.

ILLUMINATING ENGINEERING SOCIETY.
Feb. 10-11. Mid-winter convention in New York City. Secy., A. S. Miller, 29 W. 39th St., New York City.

American Water-Works Association—An organization meeting of the Four-State Section—comprising southern New Jersey, eastern Pennsylvania, Delaware and Maryland—of the American Water-Works Association will be held in Philadelphia, at the Bellevue-Stratford Hotel, on Jan. 18. Further details can be obtained from Charles R. Wood, 400 Chestnut St., Philadelphia.

The Cornell Society of Civil Engineers will hold its annual banquet at the Hotel Breslin, New York City, on Jan. 21, instead of at the Hotel McAlpin, as previously announced. The chairman of the banquet committee is Clyde Potts, 30 Church St., New York City.

The Civil Engineers' Society of St. Paul will hold its annual meeting on Jan. 15, opening with a dinner at the Commercial Club. The dinner will be followed by a program arranged by the ladies' entertainment committee, composed of the wives of outgoing officers and committee chairmen. The secretary is Carl E. Nagel.

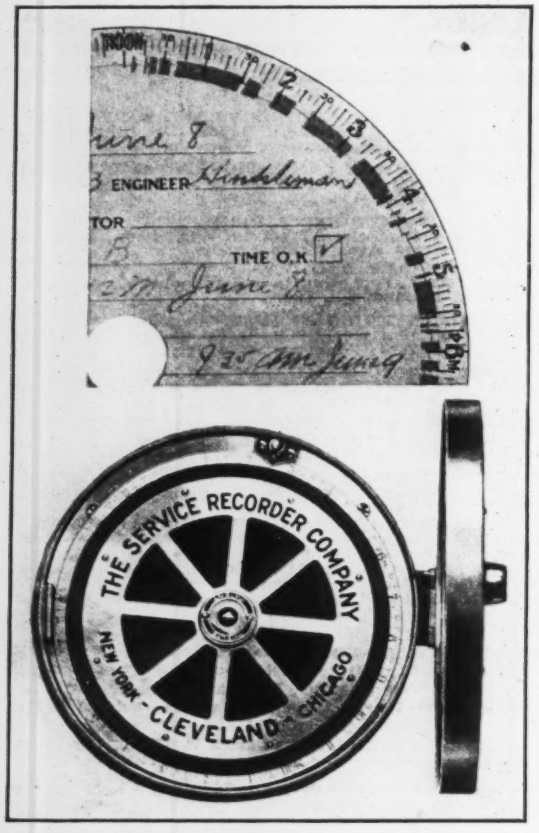
Appliances and Materials

Service Recorder for Dredges and Shovels

The "Servis Recorder" originally designed for recording the running and standing time of locomotives and motor trucks, has recently been successfully applied to steam shovels and dredges to record automatically just when and how long the equipment is working and standing. The recorder can be attached in a few minutes and is not connected to any of the running parts, being entirely self-contained.

To record operation, it uses the oscillation or sway of the equipment to which it is attached through the medium of a pendulum in it of such a period that ordinary vibration or

jars are not recorded—only that pronounced motion of the equipment which is peculiar to the actual performance of its work. The pendulum principle has been found positive and reliable in recording the movements of locomotives and vehicles and has the advantage of being simple and tamper-proof. The recorder is about 8 in. in diameter and is housed in a heavy cast-metal case. A steel protecting case is furnished in addition that can be padlocked to give extra protection against tampering and abuse. The mechanism is built to withstand severe service. The timing mechanism is a special heavy eight-day jeweled clock movement. The recording member is a sapphire-pointed stylus connected to a pendulum that is hung on a sturdy bronze bearing. The recorder is safeguarded against unauthorized opening by a plunger that cuts the chart to show at what time of day the lid is either opened or closed. The instrument needs no care or



SERVICE RECORDER FOR DREDGES; SECTION OF CHART

attention except to wind it regularly and change the charts. The accompanying view shows a "Servis Recorder" open and without its outside steel protecting case. It is manufactured by the Service Recorder Co., 2345 East 105th St., Cleveland, Ohio.

* * *

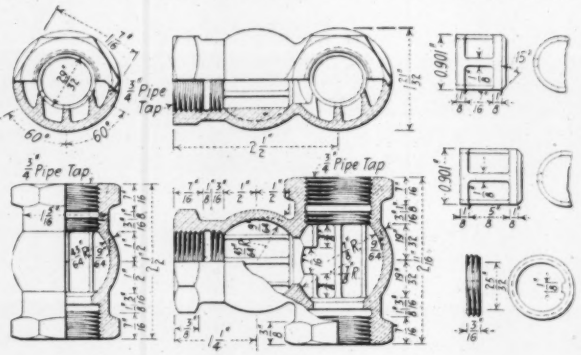
Barrel Concrete Mixer with Hoist

A small concrete mixer for farm and rural work has a barrel-shaped drum, open at one end and fitted with interior blades. For mixing, the drum is revolved on its axis by means of a chain belt passing around it. For charging and dumping, it can be swung to any angle in the supporting frame. The capacity of the drum is 2 cu.ft. wet mix, the batch being just enough for a wheelbarrow load. The frame may also be fitted with a hoisting drum for a light cable, operated through a clutch. The mixer may be driven by hand or power. It is built by the Barrel Mixer Co., of Madison, Wis.

* * *

New Design of Check Valve

A new line of water-works check and suction (double check) valves has been developed by the M. Smolensky Manufacturing Co., Cleveland, Ohio. The principal features are shown in the accompanying sketches. The basic idea was to produce a simple design and a light construction. In the smaller sizes the seat and guides are integral with the casing, which is cast of lake copper. The valve proper is a single copper casting. In the intermediate sizes an iron housing holds copper seats; the valve is of copper. In the



SMOLENSKY SUCTION AND CHECK VALVE

largest sizes the housing and valve are of iron, fitted with copper seats and rings. A half pound of metal is thus saved in the ½-in. check valve, and 50% in the larger sizes.

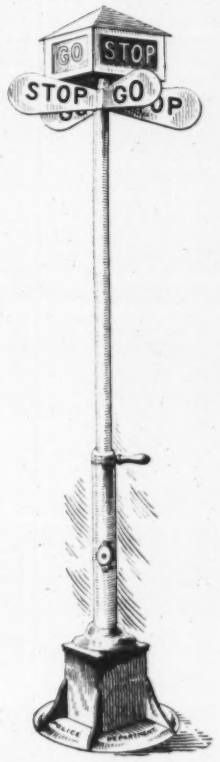
Tests are reported to show a smaller loss of pressure in the Smolensky valves than in the earlier designs. They close with smaller back pressure and may be used at any angle—even with the seat up.

The list prices run from 40c. for a ⅛-in. check to 93c. for a 1-in.; the 1¼-in. is $2.10, and the 3½-in. is $12.25. These sizes are screwed types. Flanged checks range in price from $14 for a 4-in. valve to $96 for a 9-in. and $511 for a 20-in. the suction valves range from 70c. for a 1⅛-in. size to $24.05 for a 3½-in.

* * *

Semaphore for Street-Traffic Control

It is becoming common practice to use some form of semaphore signal for regulating street traffic at busy corners rather than to depend on the whistle and hand of the traffic policeman. The most common type is a four-arm semaphore, for daylight use only, with two opposite arms painted green and lettered in white "Go," and two other opposite arms painted red and lettered "Stop." For night use, red and green bull's-eye oil lanterns are frequently attached, such as are used on railway switch signals. The semaphore design, shown in the accompanying illustration, is a litle more elaborate and exhibits the "Go" and "Stop" legends night or day. The transparent top signs are lighted by electricity either from a street connection or from a storage battery. The illustration shows the storage-battery type. The upper shaft carrying the signal is of 1¼-in. pipe, and the bottom pipe carrying the shaft is 2½ in. The shaft turns on ball bearings. This semaphore was designed and is manufactured by George L. Mesker & Co., Evansville, Ind.



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Acetylene Flare Lamps

An acetylene gas flare for general contracting, street work, fire departments, etc., has been developed by the Carbic Manufacturing Co., Duluth, Minn. This apparatus generates gas at constant pressure as required, but may be used intermittently with economy and safety. When charged for a run, no water has to be added until the entire amount of carbide is consumed. The flare complete comprises three main parts—tank, gas bell and carbide holder. The tank serves as the stand, and the bell carries the pipe column which supports the burner and reflector. The burner and reflector head is mounted on a swivel joint so that it may be swung through any angle.

The first Railroad through New York City

The New

Supplement to Engineering News, Jan. 13, 1916, Vol. 75, No. 2

The New York Connecting R.R.

Looking southwest across Manhattan Island

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Volume 75, No. 3
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Hill Publishing Company

NEW YORK, JANUARY 20, 1916

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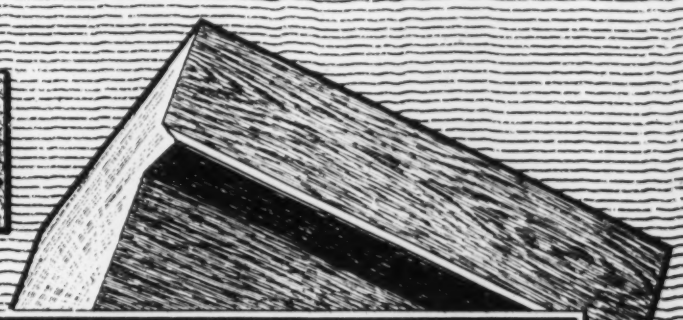
KREOLITE
LUG WOOD BLOCK
The Paving that's Saving



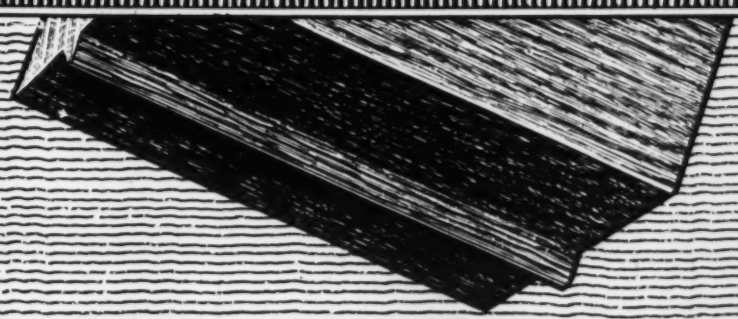
WHY THE LUGS?

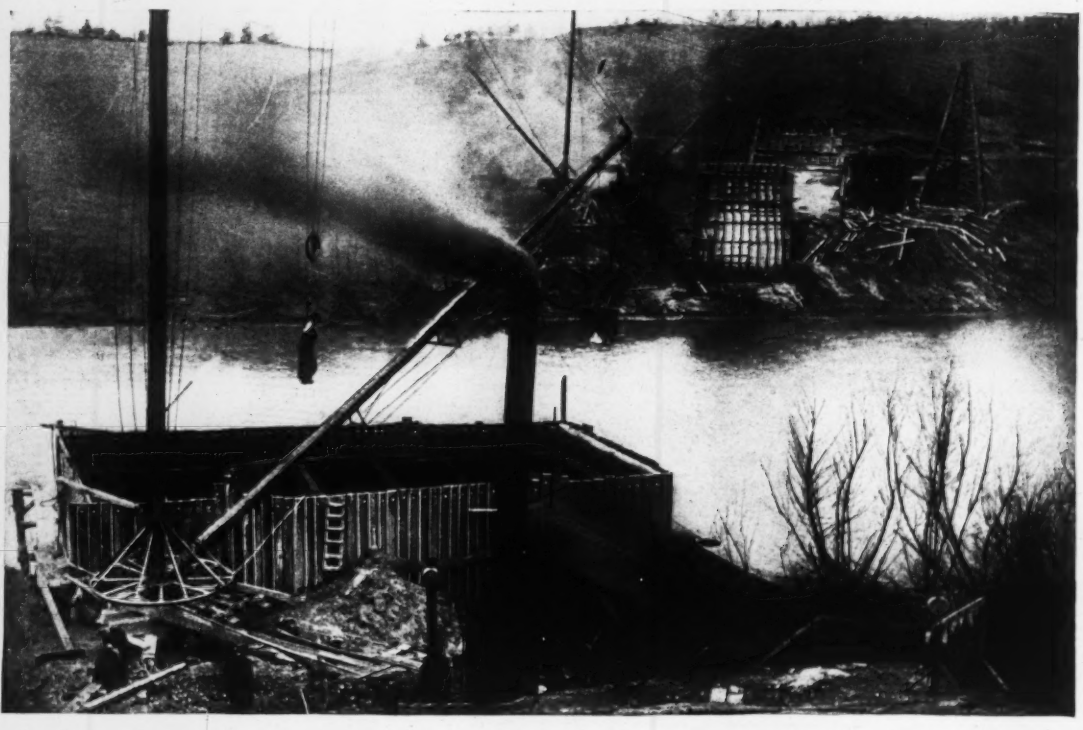
A canvass of hundreds of City and Consulting Engineers throughout the country, experienced in Wood Block Pavements, brings forth the fact that this type of pavement is considered practically ideal for both residence and business streets, when all slipperiness, buckling and bleeding are eliminated.

Municipal, County and Private corporations from New Brunswick, Canada to New Orleans, from New York City to the Pacific Coast, are laying Kreolite Lug Wood Block Pavements because they absolutely eliminate the objectionable features mentioned.

Interesting views and specifications upon request.

THE JENNISON-WRIGHT CO.
320 Huron Street Toledo, Ohio





"Lackawanna Steel Sheet Piling was Certainly a Life-Saver on That Job. Had We Tried Wooden Sheeting on Those River Cofferdams We Would be Working There Yet"

This is how Mr. G. Shipplett, Mgr. Virginia Concrete Co., Thurmond, W. Va., expressed himself about the Lackawanna Steel Sheet Piling used in foundation work on the Big Sandy River Bridge, Elkhorn Branch, Chesapeake & Ohio Railroad.

One of the cofferdams for this work is shown above. Twenty-one days' work here drove 185 40-foot lengths of Lackawanna Sheet Piling, excavated 1200 cubic yards of foundation and drove 234 18-foot lengths of bearing piles. Only one small pulsometer pump was required to keep the unwatered cofferdam dry, the steel sheet piling being practically watertight. The Lackawanna Piling after serving its purpose was pulled at an average rate of 37 sections in 20 hours (maximum 54 sections in 10 hours) and was redriven in a second cofferdam. The second driving was quicker than the first and the second pulling required only 50 hours, work by a hoisting engineer and four laborers. After the second driving and pulling this Lackawanna Sheet Piling was practically as good as new, save for about twelve pieces which also were reusable after cutting off short lengths at the end.

If you want cofferdams that are successful in every respect you will find Lackawanna Steel Sheet Piling a reliable standby. And to get the best results from this sheet piling, you can have the free cooperation and advice of our Steel Sheet Piling Engineers.

Our book "Lackawanna Steel Sheet Piling" is free to consulting, contracting and managing engineers.

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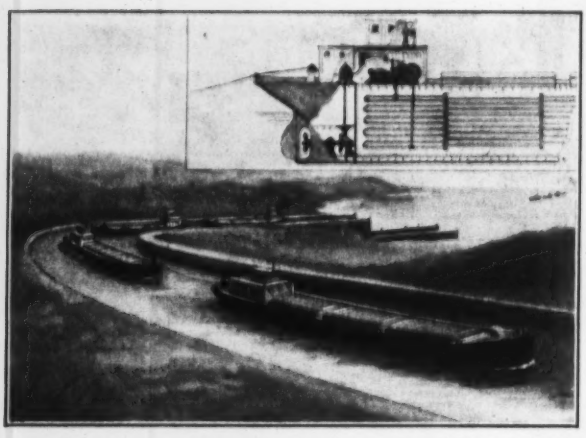

FIG. 2. PROPOSED ELECTRICALLY PROPELLED CANAL BARGES (DONNELLY PLAN)

5-ton motor truck which has a range of 50 mi. over good roads (100 mi. per 10-hr. day on a round trip), and that about 90% of the entire area of the state is within 20 mi. and may be similarly served by a 3-ton motor truck. About three-quarters of the population live within 2 mi. of the canal, and 87% within 20 mi.

The free use of the new canal will have an influence tremendously more powerful than the old canal had in building up manufacturing industries benefited by cheap transportation. Furthermore, along the Mohawk valley for a distance of 50 mi., many admirable factory sites have been created by the construction of the Barge Canal. At these sites power may be purchased cheaply, and ideal transportation facilities are available because, in addition to the Barge Canal, a free waterway of large capacity, there are available the tracks of the New York Central lines on both banks of the canalized river.

Capacity of the New Barge Canal

The New York State Barge Canal, designed to have a normal annual capacity of 10,000,000 tons, was authorized in 1903, at which time $101,000,000 was voted for a 1,000-ton barge canal. Since then $63,000,000 more has been authorized for additions, terminals, and completion.

The line of the Barge Canal, shown in Fig. 3, is also, broadly speaking, the line of the old Erie, Oswego, Champlain, and Cayuga and Seneca canals, and these names are still used to define parts of the new canal. The dimensions of the channels and locks of the old Erie Canal and the Barge Canal, shown in Figs. 3 and 4, indicate in an incomplete way their relative carrying capacities. The real difference is appreciated only after a study of the respective locations. The old canal is a land line utilizing practically no natural watercourses, while the Barge Canal traverses river and lake channels for three-quarters of its length. This superior location permits much greater capacity than is prudent on the old canal or on any land line, where a speed in excess of 3 or 4 mi. per hr. disturbs the banks.

The average speed on the new line will be between two and three times the average speed on the old. In addition to this the Barge Canal locks can accommodate single barges having a capacity of 2,500 tons, which is ten times the capacity of the barges now in service. If 2,500-ton barges are used on the new canal and the number of daily lockages is the same as on the old canal, the capacity of the new line will be from 20 to 30 times that of the old one.

The capacity of the new canal can be increased if the stretches of narrow channel or land line east of Oneida Lake are widened so that the bottom width will be 110 ft. instead of 75. Barges as large as can be accommodated on the Welland Canal may then go from Lake Ontario to the Atlantic Ocean via the Barge Canal, entering it at Oswego. The estimated cost of widening the stretches of land line is $2,000,000. The locks are already of ample width and require no change.

When traffic warrants it, the canal channel may be deepened to 14 or 15 ft. Such a depth would be in keeping with the depth of 12 ft. already provided over the sills of each lock, as that depth can accommodate a barge having a draft of 11 ft., or slightly more, and such a barge requires a channel 14 or 15 ft. deep for economical propulsion, because of the retardation, or drag in shallow channels, caused by bottom friction.

The dimensions of the present locks are out of proportion to the dimensions of the canal channels, because each lock can accommodate a single wide barge with a beam of about 43 ft., but two barges of that beam would have difficulty in passing each other in the channels of minimum section. Barges of about 800 tons' capacity

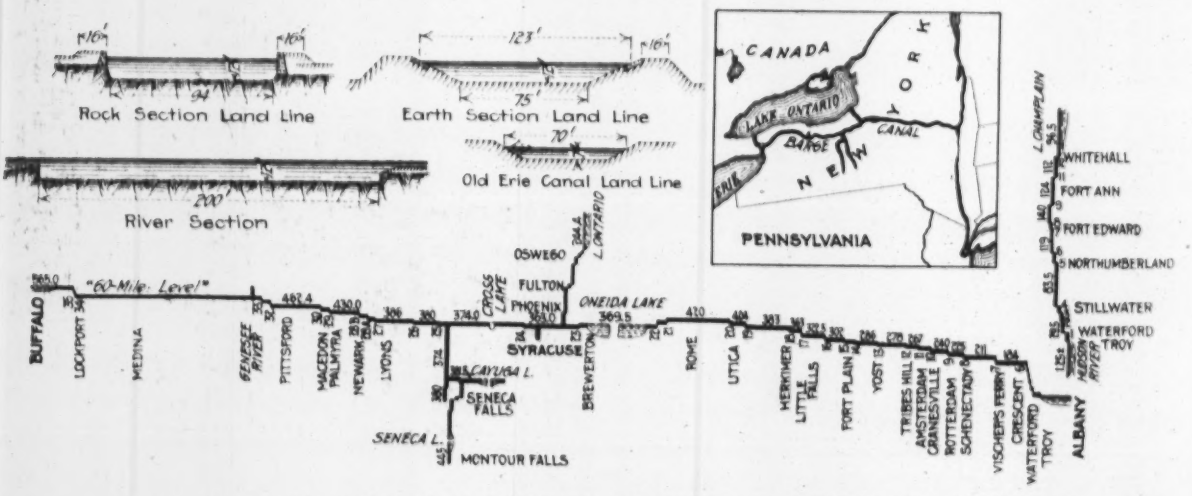

FIG. 3. CANAL MAP OF NEW YORK STATE, AND PROFILE OF STATE BARGE CANAL

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How the New York Barge Canal Will Be Operated--I

By William H. Yates*

SYNOPSIS—Capacity and service of the new State Barge Canal. The author shows that the capacity of the new canal will be 20 to 30 times that of the old, and describes in detail his designs for the operating equipment including gate-machines, valve machines, capstans and concrete lock cabins.

What the New York State Barge Canal is hardly need be explained in detail at this late day, but a few remarks on its general features and field of service are essential to orient the reader of this description of operating equipment and power system.

The influence of canals is acknowledged to be a prime factor in making New York the "Empire State" of the Union. The old Erie Canal between Albany and Buffalo, opened in 1825, was of small capacity as measured by present standards; yet in 1880 this small canal carried about 4,500,000 tons of freight—seven-tenths of the entire canal traffic of the state. In the same year about 8,700,000 tons was carried on the Erie R.R. and about 10,500,000 tons on the New York Central—the only real competitors of the canal for lakes-to-ocean traffic. Since 1880 the railroads have handled a much greater volume of freight at the expense of the canals, but the advocates of the new Barge Canal expect a reversal of transportation conditions soon after its entire length is opened to navigation.

That the new canal, on which no tolls are to be collected, is a decided asset to the state can be appreciated when it is explained that about three-quarters of the entire area of the state is within 50 mi. of some part of the canal system and may therefore be reached by a

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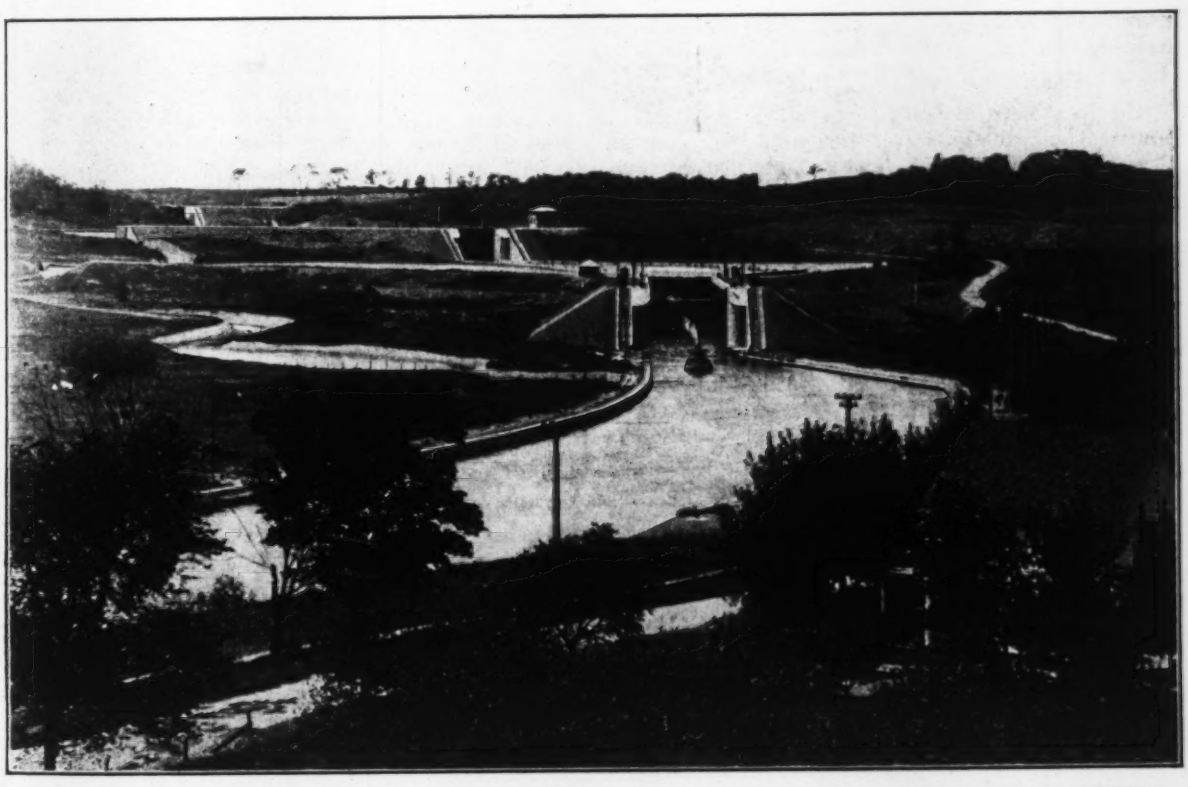


FIG. 1. THE GREATEST GROUP OF HIGH-LIFT CANAL LOCKS IN THE WORLD; THE WATERFORD FLIGHT
Locks 4, 5 and 6, Erie Canal, each having a lift of 34.5 ft.

many advantages; but if smaller barges are used, so that four can be locked through at once, the time of operating each lock will be increased on account of the greater time required to place boats in the lock chamber side by side.

While wider land-line sections would permit the use of wide barges and greatly increase the capacity of the canal at a relatively small cost, yet if any changes are made they should provide for a ship canal between Albany and Oswego to connect Lake Ontario and the Atlantic Ocean. Such a canal could be supplemented by a similar one around Niagara Falls entirely within the Empire State, so as to connect the great lakes with the Atlantic Ocean by a deep waterway shorter and safer than that now available via the Welland Canal and the St. Lawrence River and entirely within the United States.

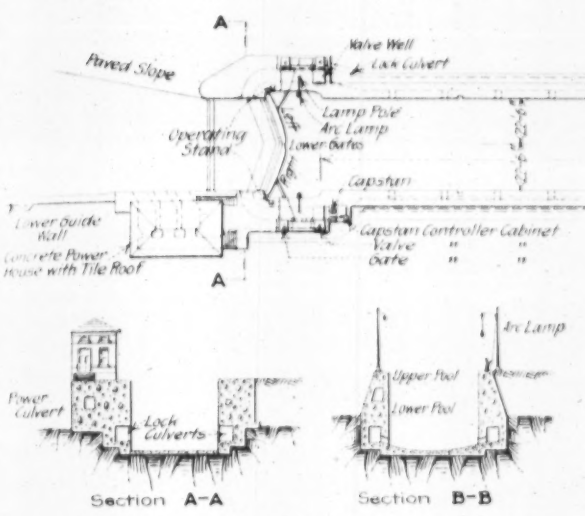


FIG. 4. PLAN AND SECTION OF TYPICAL BARGE CANAL LOCK

Barges; Terminals; Dams for Canalization

Former State Engineer J. A. Bensel has intimated ("Canal and River Barges," *Barge Canal Bulletin*, October, 1914) that ship-shaped barges similar to the Philadelphia steel barge made for use on Chesapeake Bay might be used. Tests made by United States Army Engineers (fully reported in House Document 857, Sixty-third Congress; "Experimental Towboats") indicate that barges of this type will be economical.

A novel application of electric power for propelling barges of large capacity, shown in Fig. 2, has been suggested by William T. Donnelly, Consulting Engineer (Brooklyn Engineers Club, Jan. 14, 1915). He proposes to generate power on only one boat of a tow and transmit it to its consorts on which motors alone are installed. The writer is of the opinion that individually propelled ship-shaped barges with oil engines, or in tows using electricity as mentioned, will eventually be used on the Barge Canal.

The way, or local, traffic on the canals of New York State has always been relatively heavy. Therefore terminals or, strictly speaking, docks of call, will be conveniences and important contributing factors to the large capacity of the Barge Canal. In 1911 there was voted $29,000,000 for the construction of such terminals at many cities and towns along the line of the canal. In all, 50 of these will be built. Each will consist of a dock wall, suitable mechanical means for handling cargo and a building for temporary storage. At some locations railroad sidings are available, and at all of them good roads will facilitate the handling of shipments.

The lakes traversed by the Barge Canal line needed little development to make them available for traffic, but the rivers required the construction of many new dams and the improvement of several existing ones. In all, 40 dams are used for Barge Canal purposes—5 old structures were found to be suitable, 5 have received new crests, and 30 are entirely new. Eight of these new dams are movable dams of the bridge type, similar to those used on the Moldau River in Bavaria. They have been built across the Mohawk River at Scotia, Rotterdam, Cranesville, Amsterdam, Tribes Hill, Yosts, Canajoharie and Fort Plain to form pools at each location with a minimum navigable depth of 12 ft. The eight pools thus formed and the two pools formed by the fixed dams at Crescent and Vischer's Ferry make the Mohawk River available for Barge Canal traffic for a distance of about 50 mi. A typical movable dam with lock adjacent is shown in Fig 5. Each dam comprises a highway-bridge superstructure of two or three spans, that may be used for highway traffic by the addition of a floor (as was done at Rotterdam, N. Y., in 1914).

From steel pins in the extended floor-beams of each superstructure, wickets or uprights are hung in pairs.

FIG. 5. ELECTRIC WINCH FOR OPERATING MOVABLE DAM

FIG. 6. ONE OF THE MOHAWK RIVER LOCKS AND MOVABLE DAMS, NEW YORK STATE BARGE CANAL.
Generating station and operating cabins are concrete structures rising above flood level

On them gates are supported in a nearly vertical position during the open-navigation season and swung to a horizontal position during the winter, or closed-navigation season.

To place one of the dams in service the wickets, in pairs, are first swung down until they bear against seats in the sill of each dam. These seats are located farther upstream than the steel pins from which the wickets are hung, so that the upstream edge of each wicket is an inclined plane along which each gate section rolls when being lowered or raised. The wickets are fully braced near their lower ends to prevent their being twisted by the water in lowering.

An operating platform in sections 30 ft. long, attached to each pair of wickets, is available when all the wickets are lowered, from one end of the dam to the other. This platform is 3 ft. above the pool and will facilitate handling any floating débris. It will form a most useful adjunct to the operating equipment of the movable dams.

Two electric winches are provided to raise or lower the gates. Each winch is able to operate the dam by traveling along a track supported on extensions of the floor-beams. Two steam winches which had been installed were converted to electric drive to insure more reliable operation, as well as to give the additional advantages of convenience, simplicity and economy. Fig. 5 shows a detail view of the electric winch fully equipped with top and tarpaulin cover, and trolley for chain hoist; electric lamps are provided for night operation.

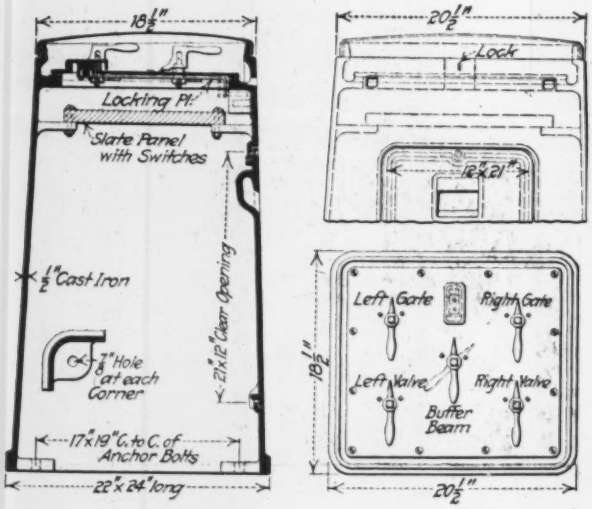


FIG. 7. LOCK-OPERATING STAND (MASTER CONTROLLER)

Dams with fixed crests also have been needed for the canalization of the rivers, notably at Crescent and Visscher's Ferry on the Mohawk River, at Mechanicsville on the Hudson River, at Phœnix and Fulton on the Oswego River and at Waterloo, Seneca Falls and Cayuga on the Seneca River. At many of these fixed dams one or more Taintor gates have been installed. The largest installation of this kind is at Dam No. 1, across the Hudson River at Mechanicsville, where there are six, as shown in Fig. 9. Each of these gates has a span of 50 ft. and is designed for a depth of water in excess of 17 ft. These dimensions make them the largest of their type in the world. Similar gates of smaller dimensions have been used in several of the previously mentioned dams, and all have given great satisfaction in operation. They are all so evenly balanced by large concrete counterweights that hand operation is depended upon entirely.

Large Size and Small Number of Locks

Next in importance to river canalization, as a contributing factor to increased capacity, is the small number and large size of the locks. Each has an available length of 311 ft., a width of 45 ft. and a depth of water over the sill of 12 ft. The lifts range from 6 to 40.5 ft. There are, in all, 57 locks. Of these, 35 are passed in traveling from Buffalo to Albany; on the old canal there were 72 locks between those points.

The recent opening of five Barge Canal locks near Waterford, known locally as the Waterford flight, demonstrated the great reduction in time of transit effected by the new locks. Seventeen locks were needed on the old canal to raise a barge from the Hudson River level (El. 15) near Waterford to the Crescent level (El. 184); but on the new canal only five locks are required for the same lift of 169 ft. When everything went well, the time of transit through the "Old Seventeen" was 4 hr., but the first trip through the "New Five" was made in about 1 hr. These five locks form the greatest group of high-lift locks in the world. Three of them can be seen in the view given by Fig. 1.

The side culverts through which the lock chamber is filled are of three standard cross-sectional areas. Their dimensions are 5x7 ft. in locks having a lift of 12 ft. or less, 6x8 ft. where the lift is between 12 and 23 ft. and 7x9 ft. where the lift exceeds 23 ft. From these side culverts the water enters the lock chamber through side ports (see Fig. 4), each having an area of about 7½ sq.ft. The ports were lined with cast-iron pipes in the first locks built, but on later contracts the lining was omitted, as investigations indicated that it was not needed to pre-

erosion. The number of ports varied with the size of the culverts; both were designed to fill the lock chamber in about 5 min. without excessive surging.

The importance of proper operation of the equipment just described is manifest. The use of electric power for the operation of the gates and valves of the locks is imperative for the safe, reliable and rapid operation required. Sufficient water power was available at most of the locks to drive hydro-electric generators, and these were generally installed; but gasoline-engine generating units were decided upon for the Mohawk River locks and in one or two isolated locations.

Reversing the usual procedure, this description will begin at the operating stand from which the gates and valves of each lock are operated and proceed to the sources of energy. Four storm-proof operating stands, designed to withstand damage from contact with mooring or towing lines, contain master switches of substantial construction and are installed at each lock in pairs, two near the upper- and lower-gate recesses respectively, as shown in Fig. 4. The master switches are of marine type similar to those installed on the decks of battleships. The contacts, being of the drum and finger type, can stand hard service. The lock gates, valves and buffer beams at each end of a lock can be operated from either side of the lock, as each operating stand includes a master switch for the separate control of each of two gate motors, two valve motors and the buffer-beam motor when it is installed.

The operating stands are marvels to all the laymen who have seen them, because by turning brass handles 3 in. long through an angle of about 40°, the operator in about 1 min. can open either leaf of a gate or either lock valve without physical effort, whereas on the old canal much work was required to swing open or to close the small wooden gates of the old locks. These were filled through openings in the lock gates. The gates of the Barge Canal locks are of steel with oak quoin and miter posts and are 26 ft. wide with heights ranging from 20 to 50 ft. Each leaf of the upper gates weighs about 20 tons. The leaves of the lower gates range in weight from 30 to 60 tons. In later designs for the lock gates of locks 2, 3 and 4, Cayuga and Seneca Canal, wooden gates were provided.

Control Apparatus Insures Safety

For safety, reliability and dispatch, all the operations attending the locking of a boat through must be properly safeguarded. All the operating equipment on the Barge Canal is so completely protected by safety devices that no damage to it can result from carelessness, ignorance or mischief.

The automatic-control apparatus for each of the motors operating the gate machines, valve machines or capstans is housed in a stormproof sheet-steel controller cabinet placed on the lock wall well back from its face, as shown in Fig. 4. The motors operating the lock gates and valves are each so controlled that it is possible to start, stop and reverse them at the will of the operator by manipulating master switches at the operating stand. An adjustable relay switch automatically disconnects the motor from the line if the current exceeds any predetermined amount under twice the normal full-load current. When the motor is so disconnected, the operator may again start it in the usual manner. A limit switch in the control system automatically reduces and then shuts off the power

FIG. 8. BARGE CANAL LOCK-GATE MACHINE AND OPERATING STAND
Steel cabinet with signal lamps rolled back from switch stand

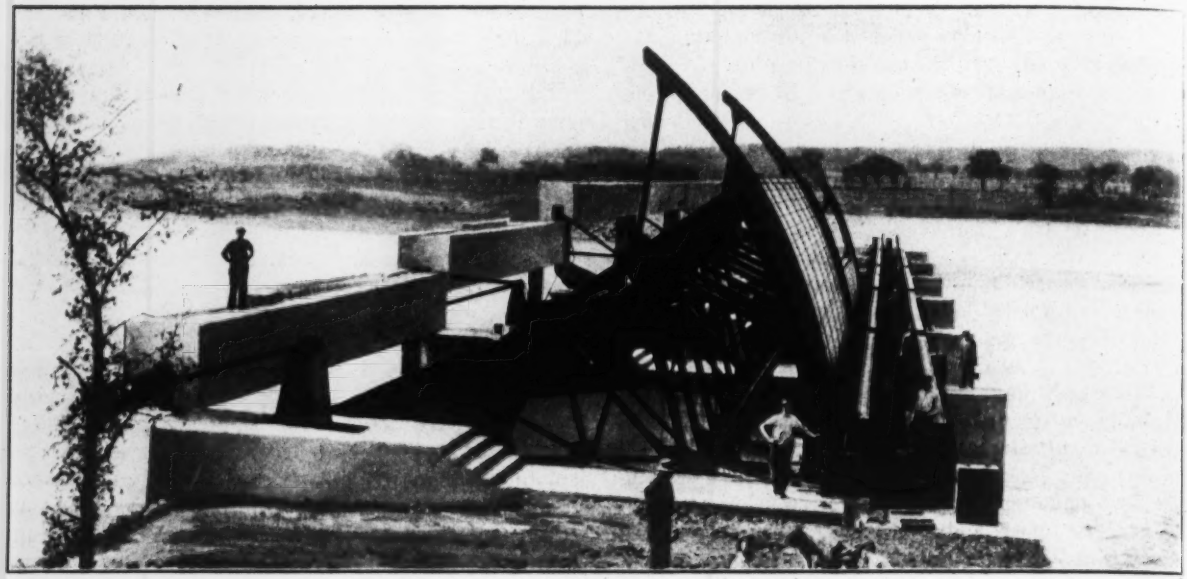


FIG. 9. THE LARGEST TAINTOR GATES IN THE WORLD; HUDSON RIVER AT MECHANICSVILLE, N. Y.
Balanced by concrete counterweights; can be operated by one man.

at each end of travel of lock gate or valve and also operates signal lights.

The nature of the work and exposed locations of the gate machines, valve machines and capstans required machinery and motors of rugged design. Totally inclosed mill-type motors of the type selected have been used successfully for years in rolling mills, where they are installed in exposed positions and do heavy work. They were developed by manufacturers of electrical apparatus and are now a commercially standard type. This selection not only avoided the development of a new and untried type of motor but made simple the replacement of parts. The insulation of the motors and of the solenoid brakes attached to them has been made impervious to oil and moisture. The motors can stand a 25% overload for 10 min. and a momentary overload of 100% without injurious heating. Factory tests of all motors made prior to shipment were supplemented by seven-day service tests at the locks.

The gate-machine motors are all series wound for 230-volt direct current. The motors operating the heavy lower gates on locks whose lifts exceed 23 ft. are rated at 10 hp.; all other gate-machine motors are rated at 7 hp. The motors operating the lower gate of lock 17 of the Erie Canal, which is of the vertical-lift type, are rated at 30 hp.

The lock-valve motors are compound wound for 230-volt direct current. The motors operating the 7x9-ft. valves are rated at 7 hp. The motors operating the 6x8- and the 5x7-ft. valves are rated at 3 hp. The capstan motors for all of the canal locks are compound wound for 230-volt direct current and are rated at 20 hp.

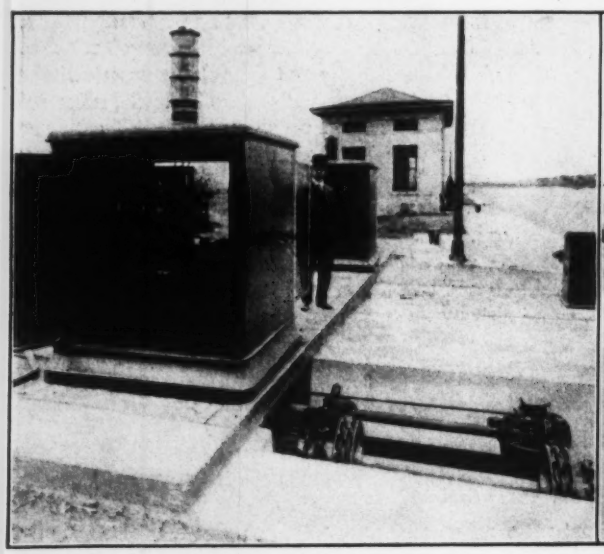


FIG. 10. LOCK-VALVE CONTROL EQUIPMENT
Master-switch (operating) stand at right; switch-group cabinet at left; substation in background

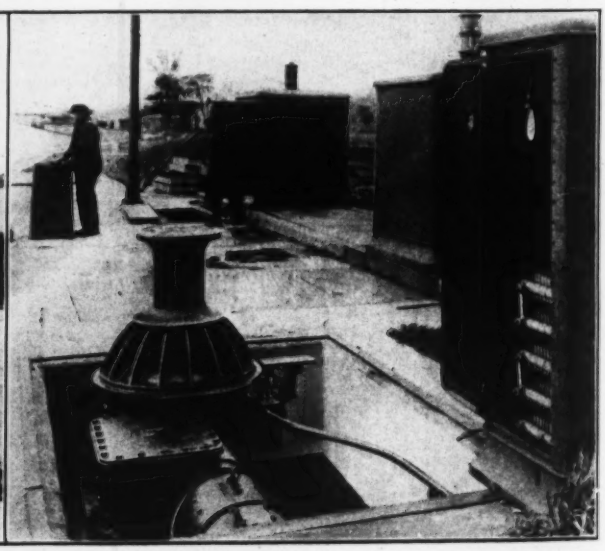


FIG. 11. ELECTRIC LOCK-WALL CAPSTAN EQUIPMENT
Man at lock operating stand in background; foot switch at right of capstan

Each gate is opened or closed by a cast-steel spar of rugged design attached to the gate and worked by an electric motor through a train of spur gears. A helical buffer spring at the outboard end of the gate spar eases the opening or closing of the gate, reduces the effect on the gate machine of any shocks or blows and permits the motor to overrun a little. All parts of the machine, shown in Fig. 8, are sturdy, being proportioned to take, at moderate intensities of stress, all operating loads that may be expected in service. Overstressing of the parts from any cause is prevented by a shear-pin safety coupling between the lowest horizontal shaft and the gear carried by it, set to slip at four times full-load torque but adjustable for other values. The limit switches installed to reduce automatically and then shut off the current at each end of travel of the gate are connected on the gate side of the coupling and will not require readjustment.

Gate Motors are Above Lock Wall

Fig. 8 shows clearly the gate motor, with its control apparatus all mounted high and dry above the top of the lock wall within easy reach and protected by sheet-steel controller cabinets provided with rollers to facilitate inspection and repair. (In older designs the lock-gate and valve-machine motors were placed below the top of the lock wall in machinery recesses under checkered-steel plate covers, where they were subjected to intermittent wetting by surges in the lock chamber.) Two signal lamps, one green and one red, are installed on top of each gate-controller cabinet. When the gates are closed the red shows and continues to show until the gate is fully open, when green appears automatically.

A wrought-iron pipe sweep is provided as part of the gear for hand operation, which is always in mesh; but before the hand sweep can be placed, a lever housed within the controller cabinet must be thrown. This disconnects the motor and opens a switch in the control circuit which prevents the motor from receiving current. Lubrication is provided for by an ample number of grease cups.

Valve Machines; Capstans; Lighting

The valve closing each of the side culverts is of the Stoney type, carried on four large wheels that roll on steel tracks bolted to a wall of the valve well. Each valve is attached to two heavy chains that pass over two cup wheels near the top of the valve well to a cast-iron counterweight. Both cup wheels are keyed to the main shaft, which is driven through a train of spur gears by a motor capable of raising the valve at a speed of 6 ft. per min. The motor with its control apparatus is located well above the top of the lock wall in a sheet-steel controller cabinet in a manner similar to the gate-machine motor and its controller as shown in Fig. 10. The valves may be raised or lowered by hand when desired, but the hand sweep cannot be inserted until a lever is thrown disconnecting the motor. Proper lubrication of parts is provided for by grease cups. Four signal lamps operated by the limit switch and mounted on top of the controller cabinet, automatically indicate the position of the valve. Blue indicates that the valve is entirely closed. One white light indicates that the valve is one-third open; two that it is two-thirds open; and three, that the valve is wide open. To prevent the valve or counterweight traveling too far, a yoke that engages buffer springs bolted to the under side of the structural-steel bed frame is clamped on the valve chains.

Each lock has two sturdy electric capstans—one at each end. Each was designed for a pull of 8,000 lb. at a speed of about 60 ft. per min. and is located in a recess shown in Fig. 11. The motor drives the capstan head through a train of spur gears and although it is located below the top of the lock wall, the entire capstan unit is so

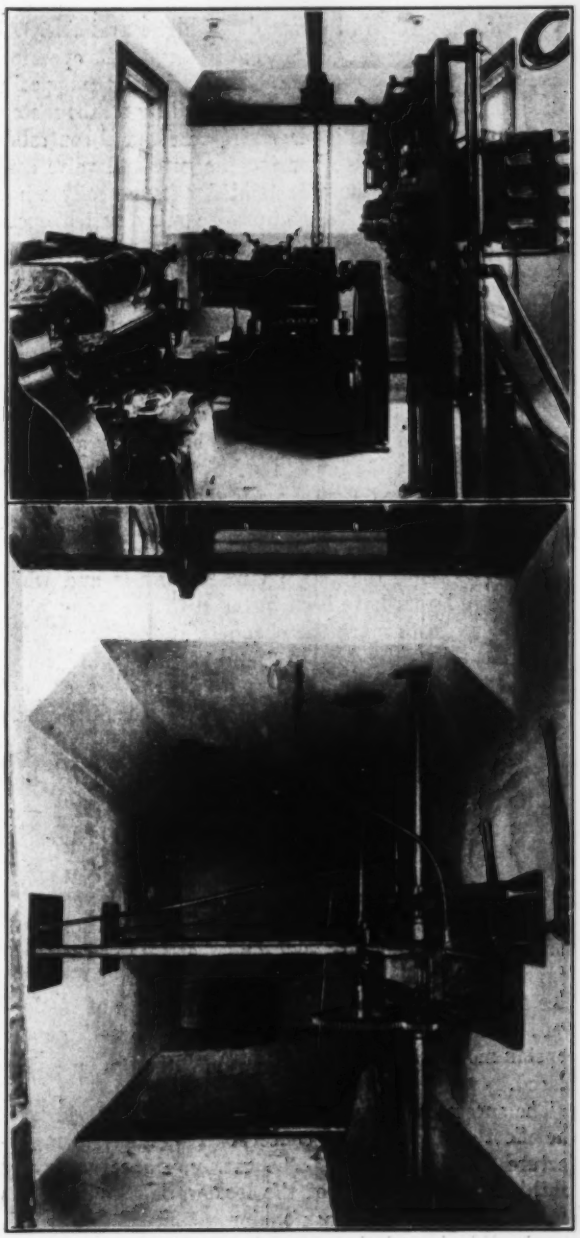


FIG. 12. UPPER AND LOWER FLOORS OF MACHINERY CABINS; MOHAWK RIVER LOCKS

These locks are overtopped by high water twice each year

constructed that no water can enter it unless water should rise more than 1 ft. above the top of the lock wall. The matter of lubrication was given special attention. Although the method of inclosing hinders an examination as easy as that of the gate and valve machines, the capstan will very probably prove more durable than the lock-gate and valve machines, because of its watertight

housing which effectively excludes dirt and grit. The master switch for the capstan is operated by a treadle set flush with the checkered-steel cover plates of the capstan recess at the elevation of the top of the lock wall and behind the capstan head, so that the operator may place the motor in service by a pressure with the toe of his boot and have both hands free for handling towing lines. Three successive pressures cut out three banks of resistance, gradually increasing the torque of the motor. A fourth makes the full torque of the motor available. At any time after placing the capstan in service the operator, can, by a pressure with the heel of his boot in the opposite direction, open the circuit, thereby shutting off the motor. The control apparatus is placed in a sheet-steel controller cabinet similar to those housing the gate and valve controllers. A signal lamp is lighted automatically when the circuit is closed. An adjustable relay switch opens the circuit if the current exceeds any predetermined amount less than twice the normal full-load current.

Lighting of the Locks

At night the locks are illuminated by 6.6-amp. magnetite-arc lamps operating two in series and located, as shown on Fig. 3, 2 ft. from the face of the lock wall so as to give ample light in the lock chamber. They are hung about 24 ft. above the top of the lock wall from wrought-iron poles equipped with lowering devices required for easy care and maintenance.

The ample lighting of the locks accentuates the lack of lighting along the Barge Canal channels and while some range lights have been installed in the larger pools now in service to mark the channels, it is expected that this system must be developed and extended until range lights of proper illuminating power, or other efficient channel markers, are installed all along the line where necessary.

Special Lock-Operating Equipment

Eight Mohawk River locks (locks 8 to 15 on the Erie Canal) required special lock-operating equipment to protect the motors and their control apparatus from high water, as these locks are overtopped twice each year. At some of them high water has reached an elevation 8 ft. above the top of the lock wall, and therefore at each lock four two-story reinforced-concrete cabins have been built. The second floor of each is 9 ft. above the top of the lock wall. On this floor the gate-machine, valve-machine and capstan motors, all with their control apparatus, have been placed.

The successful operation of all this equipment justifies the effort of all who were concerned in its design, manufacture and installation. The gate machines and valve machines below the top of the lock walls are duplicates of those of the typical lock equipment already described, but in this installation provision had to be made for operating by motors located in small cabins 9 ft. above the top of the lock wall.

The first story, or pedestal, of each cabin is 9 ft. high and is extended on the upstream side to form a concrete half-cylinder, 9 ft. in diameter and 9 ft. high, securely anchored by steel dowels to the lock wall. This bull-nose deflects floating débris or ice brought down the river by high water and thereby protects the cabins.

The interior of the second story of each cabin is painted. The floors are painted with a gray gloss paint over a filler coat well rubbed in, and the side walls are of the same color to a height of 3 ft., above which the walls and ceiling are dull white, improving the illumination and giving the entire cabin a neat and finished appearance. Each cabin has four large windows. Four tungsten lamps give ample light at night.

Steel I-beams placed near the second-story ceiling of each cabin are equipped with a chain-block trolley capable of lifting the largest motor installed. That provision has already been of much service.

[*This article will be concluded next week with descriptions of the power-generating and distributing system of the Barge Canal.*]

Thomas F. Richardson

Thomas Franklin Richardson, whose death on Dec. 26, 1915, was briefly noted in *Engineering News*, Jan. 6, 1916, was born in Woburn, Mass., Feb. 10, 1855. Soon after his graduation from the Boston High School, at the age of 18 years, he joined the engineering staff of the City of Boston as a rodman on the construction of the Sudbury River water-works. He was connected with this work as rodman and as instrumentman for five years. For a year following he was Resident Engineer in charge of the construction of a trunk sewer for the City of Chelsea, Mass.

In November, 1879, Mr. Richardson was one of the many young engineers who went West to engage in railway building. He was first Topographer on location and then Resident Engineer on construction of a section of the Atlantic & Pacific R.R. (now part of the Santa Fe) in Arizona. He had charge of the erection of the famous Cañon Diablo bridge as Construction Superintendent and Engineer.

On the record which he made here Mr. Richardson was appointed in 1882 Bridge Engineer of the south half of the Mexican Central R.R. His work included the construction of the Encarnacion viaduct, 175 ft. high and 1,300 ft. long. In 1884-85 he was also Resident Engineer of the northern half of the railroad in charge of bridge construction.

In 1885 he was appointed Division Engineer in charge of the St. Paul extension of the Chicago, Burlington & Quincy R.R. Subsequently he was Locating Engineer for the same railway in western Colorado. From 1887 to 1891 his career was the knockabout experience common to the Western railway builder. He was successively Division and Resident Engineer of the Chicago extension of the Santa Fe, Locating Engineer of the Denver & Rio Grande, Locating and Chief Engineer of the Manitou & Pike's Peak R.R.—a rack railway reaching an elevation of 14,100 ft.—Locating Engineer of the Mexican Central and again Chief Engineer of the Manitou & Pike's Peak.

Mr. Richardson returned to the East in 1891, as far as Chicago, where he was appointed Assistant Engineer in charge of a part of the work for the Sanitary District.

Subsequently he was in charge of construction of a 4-mi. water-works tunnel in 68th St. From here he returned to the scene of his earliest experience, Boston, where he was placed in charge of the investigation of the Metropolitan Water-Works, and later in charge of the construction of the Wachusett aqueduct and dam.

For a brief space of time in 1906 he was Construction Superintendent of the Laguna dam in Arizona, for the United States Government, after which he returned to Boston and to his former position on the Metropolitan Water-Works. At the end of three months he resigned to take charge of the construction of the plant of the Rockingham Power Co. on the Peedee River, North Carolina. In 1907 he was appointed Superintendent of Construction of J. G. White & Co., New York City, and as such had charge of much important construction work, including the plants of the La Crosse Power Co. in Wisconsin, the Connecticut River Power Co. in Vermont, the Central Georgia Power Co. and several in the far West. From Sept. 1, 1909, until recently he was Chief Civil Engineer of the company.

Mr. Richardson was a member of the American Society of Civil Engineers, the Boston Society of Civil Engineers, the New England Water-Works Association and the Engineers' Club, New York City.

Utility Service Rules Adopted in California

During the summer of 1915 the California Railroad Commission completed an investigation on its own initiative with a view to establishing uniform practices among water, gas, electric and telephone utilities in regard to their minimum charges, deposit guarantees, contracts, service connections and extensions. Finally a series of rules was established covering this part of the service of these utilities. These are reprinted in "Public Utilities Reports," 1915 E, p. 717.

There are nine rules outlining the imposition of service charges. The first provides that, under uniform and nondiscriminatory regulations, applicants for measured service may be required to establish their credit. This is done by owning the premises, making a cash deposit, furnishing a guarantor or by the payment of all bills for 12 months prior to the date of the order. Rule 2 limits cash deposits for insuring payment to not over twice the average periodic bill of customers in an applicant's class. The deposit is not to exceed $2.50 for domestic service.

An applicant who establishes credit but later fails to pay his bills may be required to make a cash deposit. The company may apply a cash deposit against an unpaid bill for metered service and may require that the deposit be restored to the original amount.

Rule 5 requires 15 calendar days' notice before discontinuing a metered service where a customer has failed to make a proper cash deposit in cases where bills are made out monthly. Where bills are made out weekly, four days' notice must be given. Where bills are made out fortnightly, the notice must cover seven days. Where bills are made out at periods of over one month, 30 days' notice must be given. A utility may not discontinue service by reason of nonpayment of bills for measured service theretofore delivered.

Deposits; Contracts; Service Connections

Under rule 7 a telephone utility may extend the convenience of sending telegrams and long-distance telephone messages on credit or against deposit. Payment for all flat-rate services may be required in advance for a period not greater than that for which bills are regularly rendered. Failure to pay for flat-rate service may be discontinued after 15 days' notice where bills are made out monthly, after four days where bills are made out weekly, after seven days where bills are made out fortnightly and after 30 days where bills are made out for periods exceeding one month.

By rule 10, after a cash deposit to guarantee payment for metered or measured service has stood unimpaired for 12 months it must be returned to the depositor. On closing any account the balance of any deposit remaining must be promptly returned. Interest at 6% must be paid by these utilities on all deposits held to secure payment of bills for metered service. But interest need not be paid if the service is discontinued within less than 12 months.

In general a utility may not require an applicant to sign a contract to take service, but it may require reasonable written application for the service. Exceptions are made in the case of extensions into unincorporated territory, etc.

A utility operating upon, under or along a public way is required, by rule 13, to install a service connection to the property line or curb line of abutting property—or to such point on the consumer's premises as may be agreed upon. "Service Connections" include water and gas pipes, electric and telephone wires, water, gas and electric meters, electric tranformers, gas regulators, telephone instruments and appurtenances. Utilities may refuse to make a service connection if service is not expected to be taken immediately.

Under reasonable nondiscriminatory regulations a utility may charge the cost of establishing and discontinuing service connections directly to the new or the resuming consumer, or it may distribute periodic payments over a reasonable period of time or merge these costs in the general operating expenses. Cancellation charges are abolished.

Extensions; Modification of Rules

A utility operating under a general franchise authorizing the occupancy of all the streets of a municipality must, by rule 15, make street extensions at its own expense, except where extensions at the utility's sole cost will work undue hardship on the utility or existing consumers, and then the matter may be submitted to the commission. Rule 16 requires such extensions in unincorporated territory at the expense of the utility as can be agreed upon with the applicant for service. Where construction of an extension at the utility's sole expense will work undue hardship on the utility or existing customers, the matter may be submitted to the commission.

Where an applicant makes payment to the utility to secure construction of an extension, this payment is to be regarded as a loan to the utility on which interest must be paid at 6% and the principal repaid under reasonable regulations.

A utility may establish uniform nondiscriminatory rules more favorable to its customers than the rules established by the commission.

The new rules and regulations take precedence over earlier orders of the commission inconsistent with the rules. They also take precedence over all rules and regulations filed or to be filed by water, gas, electric and telephone companies, so far as the filed rules and regulations are inconsistent with the new ones.

Reservoir and Concrete Dam in Glacial Drift

By H. J. Langlois*

SYNOPSIS—Earth dam planned but abandoned for lack of proper material and good foundations. Design and construction of reinforced-concrete deck dam, with cost data given. Stopping leaks from the reservoir with clay.

A water-supply storage reservoir has recently been created by the City of Plattsburg, N. Y., in the foothills of the Adirondacks by throwing a reinforced-concrete dam across a brook which meanders down between high gravel banks. The construction of the dam and the work of making the reservoir tight are of particular interest and deserve recording.

Plattsburg (population 12,000) obtains its water-supply from the drainage area of West Brook, in Beekmantown, Clinton County. The first reservoir was built on this stream in 1907 and the second in 1910. When the average daily consumption rose to 2½ million gallons, in 1912, the 172 million gallons' supply in the lower reservoirs was found insufficient for the winter months, and additional storage became imperative. There was no need of seeking new watersheds, as the drainage area of West Brook is 7.4 sq.mi. and the average flow is 8 sec.-ft.

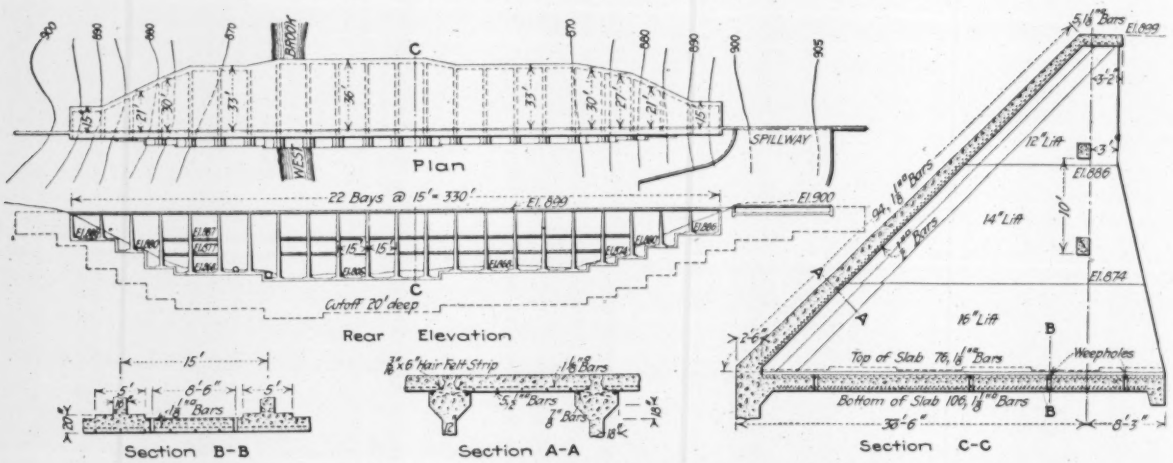


FIG. 1. REINFORCED-CONCRETE DAM AT RESERVOIR NO. 3, PLATTSBURG, N. Y.

Surveys were made in the fall of 1912. The site finally selected for the third reservoir is shown in Fig. 2 and is on Lot 84, Duerville Patent, Beekmantown. The drainage area above is 4.6 sq.mi., and the average flow is 5.3 sec.-ft. About one month's supply, or 72 million gallons, can be impounded.

Adapting the Dam to the Ground

The preliminary design, planned by the writer as City Engineer, called for an earth dam with a reinforced-concrete corewall and spillway—following the construction, as to the dam proper, found at reservoirs 1 and 2. R. E. Horton, of Albany, was retained as consulting engineer on the preliminary plans. The soil conditions at the new dam were similar to those at dam No. 2, and that reservoir was examined. Some leakage was found around the left end of the dam, where the core wall was less than 20 ft. down; there was some seepage through the natural bank on the left end. It was seen that the core wall of the new dam would have to go deep; but no difficulty was anticipated with flow through the banks, since their general level was higher than the elevation of the proposed flow line and the seepage path would be longer than at dam No. 2. It was believed that the ground-water table back of the new-reservoir site stood higher than the proposed flow line, so that the only change would be a reduction of underground water gradient toward the brook when the reservoir was full. It was expected that the reservoir, by virtue of storage in the banks, would yield a slightly greater volume of water than the computed contents. Such an effect had been noted at a similar site—the Gray reservoir of the Consolidated Water Co., on Black Creek near Utica, N. Y.

To determine the stability of foundations and the availability of suitable material for an earth dam, various quick tests were made at the site in the summer of 1913. A pit 6 ft. square was dug on the line of the proposed corewall 35 ft. to the right and 6 ft. below the bed of the stream. The excavated material was uniform in character, with 25% boulders; of the remaining material about 35% was fine gravel, 1.5% very coarse sand, 3% coarse, 5% medium coarse, 5% medium, 11% medium fine, 1.5% fine and 38% very fine sand and silt (passing a 100-mesh screen). Samples taken from other pits showed much the same characteristics.

There was not more than 3 to 5% of clayey material in any samples of the finest material. There was less than 1% in the run-of-bank—compared with the 10 to 12% known to be desirable. Under a head of 5.2 ft. between the brook and the main test pit already mentioned, a flow of 17.4 gal. per hr. was noted. This fact suggested considerable percolation through the silt and

*City Engineer, Plattsburg, N. Y.

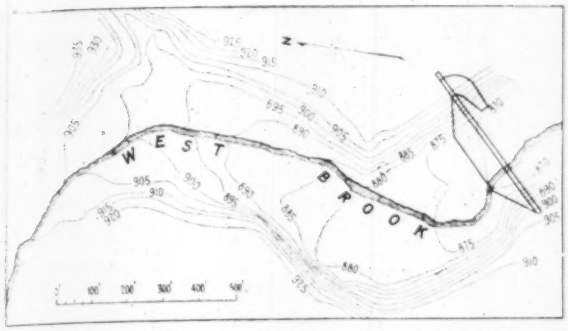


FIG. 2. RESERVOIR NO. 3, PLATTSBURG, N. Y.

probability of complete saturation of the upstream part of the earth dam. The flow was not great enough, however, to prevent creating a reservoir at the site—particularly as any leakage would be caught in the lower reservoirs. Therefore Mr. Horton recommended building a hollow reinforced-concrete inclined-deck dam with the cutoff wall at the upstream toe. Such a type had been used at the Gray reservoir, mentioned before, and had been in service some eight years.

Design and Construction of Concrete Dam

A concrete dam of the Ambursen type was designed and built. The dam is of bulkhead section with triangular buttresses. It is 35 ft. high and 330 ft. long with a 50-ft. spillway around the east end. The cutoff wall extends into the banks 20 ft. at each end, making the total length of the structure 420 ft. The elevation of the top is 900, the spillway crest 897 and the lowest floor level 865. The waste pipe is 24 in. in diameter and the supply pipe is 16. They are at El. 865 and 869 respectively.

The spillway discharges the water upon a concrete apron laid to the foot of the east slope. The deck slab rests upon 23 triangular buttresses set 15 ft. center to center and parallel to the brook. The upstream edges have a slope of 45 deg. and were constructed with haunches for the casting of the deck slab. The buttresses rest upon a reinforced-concrete floor extending the entire length and width of the dam. A cutoff wall, 30 in. thick, was placed under the toe of the dam. The cutoff trench extended 15 to 22 ft. below the ground level. No rock was encountered.

Work was commenced on the cutoff and floor in October, 1913, and suspended at the end of December. During that time the cutoff and floor were completed from buttress No. 5 to buttress No. 19. The stream was carried over in a flume. Koppel cars and track were used in placing the concrete, and a small derrick for the cutoff-trench excavation. Up to Dec. 31, 1913, the general excavation amounted to 2,580 cu.yd., and the cutoff trench to 920 cu.yd. more; 840 cu.yd. of 1:3:6 concrete and 181,380 lb. of reinforcing steel were in place.

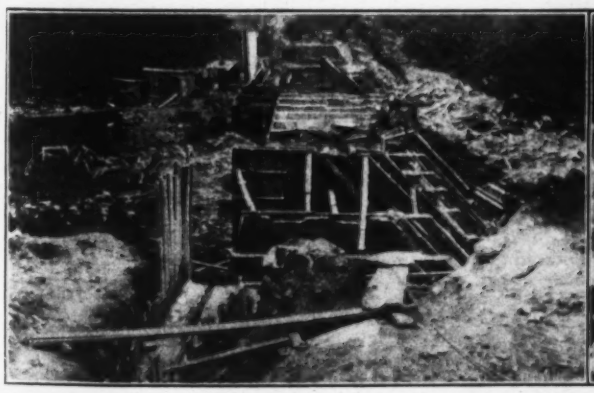
Work was resumed in June, 1914, the delay being caused by failure to sell the necessary bonds. Upon the completion of the floor and trench work to level 870, a cableway and carrier were installed. The remaining part of the dam was poured by this method. A 15-ft. cube mixer was placed at level 870 in the rear of buttress 4, the cement being hauled in on the lower level. A stone-crushing plant was erected on the west bank at level 905. The field stone and sand were hauled to the upper level and carried to the mixer by means of a short track and hopper over the mixer set-up. The stone used was ¾- to 2½-in., and the dust was used with the sand.

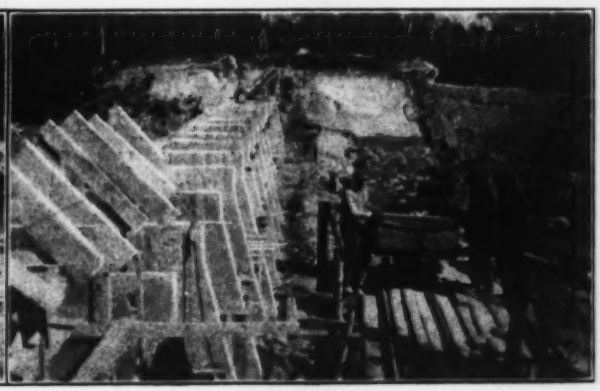
Reinforcing; Buttresses; Spillway

Corrugated square bars were used for reinforcement. The floor was double reinforced with 1⅛-in. bars spaced from 6 to 10 in. for the various levels and resting upon ½-in. bars spaced 30 in. apart throughout the entire floor. Field joints were wired and lapped at least 3 ft. The floor thickness varied from 18 in. for level 865 to 12 in. for level 886. Four-inch weep holes spaced 5 ft. apart were placed in the floor.

The buttresses were made in three lifts, 16, 14 and 12 in. in thickness and molded to the outside face line of the deck. They were reinforced with two ⅞-in. bars laid horizontally, full length of the buttress, and at each 5-ft. rise in elevation. On the upstream edge of the buttresses an 18-in. haunch was cast on both sides integral with the buttresses. A shoulder was cast in the haunch to afford support for the underforming of the deck slab. The haunches were reinforced with ½-in. hook bars staggered 9 in. apart, and two ⅞-in. bars the entire length of the haunch.

The sides of the buttresses above the haunch were coated with a ½-in. layer of asphalt. The deck slab was keyed at the cutoff wall and each lift with 6-in. V-shaped keys. The deck slab was 30 in. thick at the toe and 15 in. at the top of the dam. A 6-ft. walk was built across the top. The deck was reinforced with 1⅛-in.





FIGS. 3 AND 4. PLATTSBURG REINFORCED-CONCRETE DAM UNDER CONSTRUCTION
Fig. 3—Looking southwest; cutoff wall in foreground. Fig. 4—Looking northeast toward spillway apron

bars spaced from 4½ in. at the bottom to 10½ in. at the top, tied to ½-in. bars spaced 30 in. between buttresses. The cutoff wall contains 649 cu.yd. of 1:3:6 concrete, the floor 806 cu.yd. of 1:3:6 and the buttresses 829 cu.yd. of the same mixture. The deck slab is of 1:2:4 concrete and amounts to 925 cu.yd.

The spillway is 50 ft. wide with 3 ft. height of opening. It extends around the end of the dam in a quarter circle and down the east slope in a line parallel with the line of the dam. It is reinforced with ½-in. bars spaced 12 in. both ways. The side walls are 3 ft. high and 1 ft. thick. A baffle of large stones set in concrete was placed at the bottom of the spillway and at each pipe outlet. The bridge across the spillway consists of four 12-in. 40-lb. I-beams, 25 ft. long, supporting a 5-in. reinforced slab of concrete.

At El. 887 1x1.2-ft. beams or struts were placed between buttresses 4 to 6 and 8 to 20, and at El. 877, 1.2x1.4-ft. struts between buttresses 4 to 6 and 8 to 19.

The supply pipe is located in bay 6 and the drain in bay 7. In these bays curtain walls were constructed 20 ft. back from the toe and running up to the deck. Each wall had a double door—steel outside and wood inside. Further precaution was taken to prevent the valves freezing in, as the temperature drops to 35° below zero in this locality. A 6-in. wall 3 ft. high was built along each side of each pipe out to the end and 18 in. away. In this space charcoal dust was packed to 1 ft. above the pipe. A cushion of leaves and a board floor were added. The outlet ends of the pipes were capped with hinged wooden flaps. Tools and a boat are to be stored in one of the pipe chambers. Above buttress 7 in the walk floor are two 3-in. pipe sockets for davits.

The following data summarize the construction:

3,844.9 cu.yd. excavation at $1	$3,844.90
872.4 cu.yd. trench excavation to 10-ft. depth at $3.50	3,053.40
436.1 cu.yd. 15-ft. depth at $4.50	1,962.45
309.4 cu.yd. below 15-ft. depth at $5.50	1,701.70
1,390 cu.yd. backfill at toe at $0.50	695.00
2,283.6 cu.yd. 1:3:6 concrete at $8.70	19,867.32
1,245.8 cu.yd. 1:2:4 concrete at $9.12	11,361.70
359,000 lb. steel reinforcement at $0.03	11,070.00
36 lin.ft. 24-in. pipe	144.00
36 lin.ft. 16-in. pipe	126.00
130 sq.yd. baffle at pipe ends and spillway at $3	390.00
Gates, valves, screens, flanges, etc., lump sum	500.00
Total	$54,716.47

The dam was completed Jan. 10, 1915. The contractors were J. J. Fitzpatrick & Sons, Plattsburg, N. Y., and the work was under the supervision of the City Engineer.

Leakage from the Reservoir

Upon the completion of the dam in January, 1915, the gates were closed and the reservoir filled to El. 897. Slight leakage was found through the deck slab, but this stopped entirely in two months. A small amount of seepage was discovered around buttresses 16 to 19, and considerable seepage under buttress 4 and around under the floor between buttresses 2 and 3. This seepage continued throughout the summer, and although no weir measurements were taken, it appeared to be gradually growing smaller.

As soon as the Plattsburg summer military encampment closed and the need of keeping on hand the maximum supply had temporarily passed, the reservoir was drained; and an expert from the Ambursen Co. and other engineers visited the dam. Owing to the glacial-drift deposit which occurs in this section of the country and upon which the dam rested, it was decided that it was impossible to prevent a certain amount of seepage without the aid of a clay carpet in front of the dam.

Excavation was commenced Sept. 22, 1915. A trench 10 ft. deep was excavated from buttress 7 to 22 ft. below the ground level at buttress 1; it was 6 ft. to 10 ft. wide at the top and 3 ft. wide at the bottom. A 6-ft. trench 5 ft. wide at the top and 3 ft. wide at the bottom was excavated from buttress 7 to buttress 19. In these trenches it was decided to place a sand and clay mixture, thoroughly puddled and compacted. An inspector from the State Conservation Commission (having jurisdiction over dams) visited the work and approved of the methods used. A clay deposit was found 3¼ mi. from the dam, and sand in a pit 50 ft. from the west end of the dam was used. Upon inspection in front of buttress 4, a white-sand seam was discovered; it was cut off and filled with sand-clay mixture. Koppel cars were used to convey the material to the top of the dam, whence it was dumped down the face of the dam, mixed by hand, tamped and puddled in the excavation. The material was proportioned 65% sand to 35% clay; 600 cu.yd. of clay was hauled. The work was completed Nov. 26, 1915. Ideal weather was experienced, there being no frosts.

Cost of Stopping Leaks

The cost of the work was $3,033, of which $864 was for hauling clay, $182 was for excavating clay at pit, $505 for excavating trench, $340 for excavating and screening sand, $600 for mixing and placing sand-clay mixture, $116 for pumping (a 4-in. pulsometer being used), $45 for wood for firing boiler and $391 for use of contractor's plant, superintendence, etc. The cost of the clay delivered on the job was $1.73 per cu.yd., and sand in the cars was 29c. per cu.yd.

The gates were closed, and with the water at El. 879, giving a head of 14 ft., no signs of seepage were detected along the line of work. Up to date it has not been feasible to hold back the water in this reservoir, but it is safe to assume that there will be very little seepage encountered when the spring freshets give opportunity to fill the reservoir to its capacity.

The Water Hyacinth, which has given so much trouble by obstructing navigable streams in Florida and Louisiana, has appeared in the waters of the Panama Canal, especially in Gatun Lake. The annual report of W. G. Comber, resident engineer in charge of the dredging division at Panama, states that during the year 135,000 sq.yd. of old hyacinths was killed by poisoning, and about 600,000 young plants were pulled up and deposited on the shore. Very few old plants can now be found, and practically none have been allowed to seed since January, 1915. The Chagres valley and the lake had been so thoroughly seeded prior to this, however, that it requires constant inspection and a force of men to pull the young plants before they have time to seed. The isthmian water hyacinth is native in nearly all the waters of the Atlantic Slope from Colombia to Costa Rica. It is supposed that the floods from the upper Chagres have distributed plants and seeds over a wide area of Gatun Lake. The plant grows in water from 1 to 16 ft. deep on either muddy or rocky bottom. It grows very rapidly and forms a thick matted mass on the surface of the water. A bed of plants six months old will support a man on a 6-in. board. The plant begins blooming in about six weeks from the time it appears above the surface of the water, and mature seeds will be formed in eight weeks more. Each healthy plant will distribute about 170,000 seeds a year. The seeds germinate in anywhere from one to six months, so that even though a bed is destroyed new plants will appear on the same area for a long time. Mr. Comber believes, however, that the campaign against the hyacinth has begun in time and that the small amount of current in the lake will enable the plant to be finally exterminated from it by two or three years' work.

Inclosing 2,500,000-Gal. Steel Water Tank with Masonry

Steel water tanks of 2,500,000-gal. capacity are few and far between, and not many of them are inclosed with masonry, as is the case with the tank here illustrated. This tank, which is located on Bellevue Hill in the West Roxbury district of Boston, was built in 1914-15 by the Metropolitan Water and Sewerage Board as part of the Metropolitan water-works for Boston and vicinity. It rests on a concrete foundation, is 100 ft. in diameter and 44 ft. 3 in. high (see *Engineering News*, Nov. 12, 1914, p. 1101, for a brief description of the tank).

Early in 1915 the board let a contract for inclosing the steel tank with masonry walls composed of Rockport granite backed with concrete and with a roof made up of steel framework supporting reinforced concrete covered with a layer of reinforced asphalt, except on the turret portion of the roof, which is covered with Imperial German interlocking roofing tiles. A general view of the tank after it was inclosed is shown by Fig. 1, while Fig. 2 shows the framework of the roof and the details of the cornice.

The diameter of the masonry tower at the bottom is 114 ft. 2 in. on the outside and 108 ft. 2 in. on the inside. The height of the inclosing masonry is 47 ft. from the concrete foundation to the top of the cornice, and above the cornice there is a parapet 4 ft. high surrounding the roof. As may be seen from Fig. 2, the roof slopes gradually upward from the cornice for some distance, where it changes to a hexagonal turret with a pyramidal roof rising about 16 ft. above the main roof. Besides the support given by the masonry tower, the steel roof trusses are supported on six steel columns extending downward to the bottom of the tank.

Below the ground line the granite facing is omitted from the concrete, or in other words the wall is entirely of concrete. The granite is quarry faced with squared joints, dressed "to lay with face joints not more than 1 in. thick at any place, averaging not more than ¾ in. thickness." From a point 6 in. back from the face

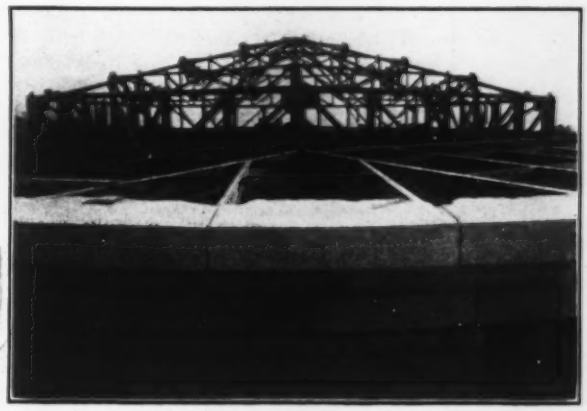


FIG. 2. DETAILS OF WATER-TOWER CORNICE AND ROOF

the joints may increase in thickness, but must not exceed 4 in. anywhere. Above the water-table rock-face, broken-range ashlar was used, and below the water-table rock-face, coursed ashlar was used. The water table and various other ornamental portions of the masonry are of dressed stone.

The turret walls are of 4x12-in. hollow terra-cotta Natco XXX blocks laid in cement and plastered with cement on the outside face. The specification for this plastering was as follows:

> The outside of the blocks shall be given three coats of plaster, the first coat to consist of mortar of 1 volume of cement and 3 volumes of sand to which shall be added from 10 to 20% of its volume of lime putty, containing 50 lb. of long cattle hair to each barrel of lime, and this coat shall be well broomed or otherwise roughened. The second coat shall be of the same materials and applied in the same manner as the first coat except that less hair may be used, subject to the approval of the engineer. The finishing coat of mortar shall be composed of 1 part by volume of cement and 2 parts of sand, and 10% of hydrated lime. It shall be applied in a workmanlike manner by skilled workmen and shall be of even thickness with true surface throughout and shall have a carpet or stippled finish of a color and texture satisfactory to the engineer. Should cracks develop in any portion of the finished surface before the contract is completed, the plaster shall be replaced in a satisfactory manner.

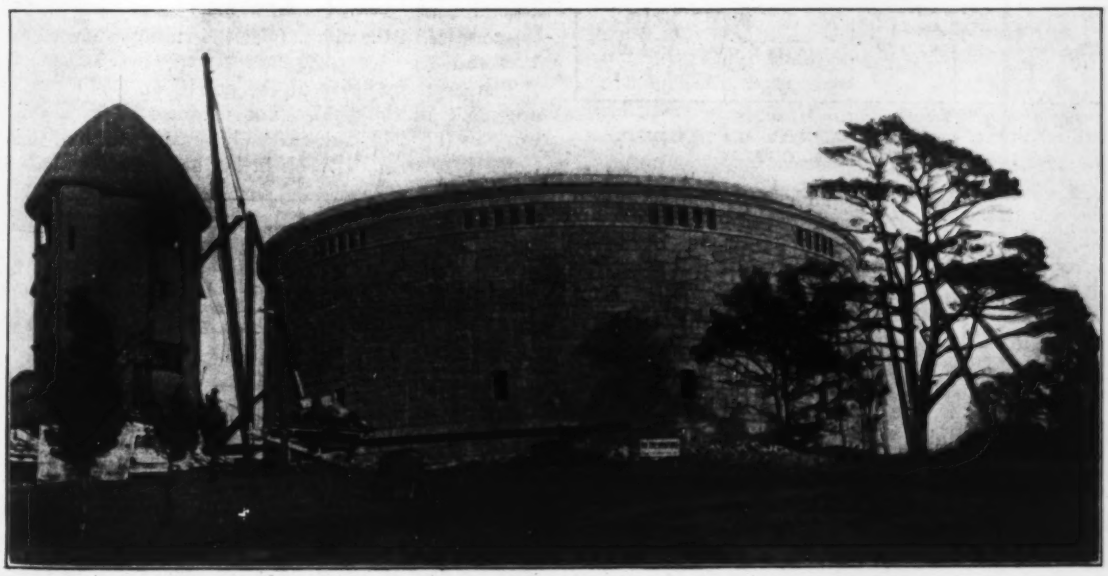


FIG. 1. MASONRY-INCLOSED STEEL WATER TANK, METROPOLITAN WATER-WORKS, BOSTON

The tiles for the turret roof are dull green, 16x9 in. in size. Imperial German roof tiling was laid with 8x 13⅜-in. exposure on the steel angles of the roof framework and fastened with suitable copper clips. The specification provided that the tiles must be well locked together and so laid that the faces will be smooth and the vertical lines parallel and at right angles to the eaves, with no attempt "to stretch the courses." Oakum was "inserted on the head lock" to give the tiles "a cushion and to stop draft."

The reinforced-concrete roofing was described in a [illegible] published on page 1264 of *Engineering News* of Dec. [illegible] 1915.

The late Dexter Brackett was Chief Engineer of [illegible] Metropolitan Water-Works when the work was begun. William E. Foss was Division Engineer until the death of Mr. Brackett on Aug. 26, 1915, and has been acting Chief Engineer since that time. The contractor for the masonry work described was the John Cashman & Son Co., of Boston.

Construction Engineers' Field and Office Diary

By J. C. L. Fish*

SYNOPSIS. Systematic plan of keeping diary of resident engineer on railway construction performed under contract. Plan applicable to other classes of construction work. Diary divided into two coordinating parts—the Field Diary and the Office Diary.

The writer for some months kept his resident engineer's diary in the customary way, writing each evening the record of the day's work. He has had frequent occasion to search his own diaries and those of others kept in this way, and has found such records seriously lacking both in details and in items. Furthermore, so great is the time required to find the items pertaining, say, to a structure which was in progress during several months,

MILE 47 SHOVEL NO. 3 CUT 440* P. 3

DATE 1912	Time	Shovel at	Dumping at	Classification	Remarks
May 16	10.30 A.	446+30	427+20	2'E on 35%R	on unf. fill over 8R
	2 trains, 8 cars each, 5L in pit, 12L on dump, 2 trackmen shot up for 100' ahead of shovel. Shovel 12' above grade — told foreman so. Foreman asked for 6L stakes and grade on fill 420. Told foreman he was cutting beyond slope stakes and to stop it. This is second time I have called this to his notice. Foreman says delay of 2 hours this morning account cars off track.				
May 17	4.00 P.M.	446+70	427+40 widening	2½'E on 32%R	unf. over 8R
	etc.	etc.	etc.	etc.	etc.

*Cut designated by the even Ten Station in the Cut

FIG. 1. TYPICAL OF ENTRIES IN FIELD DIARY FOR A STEAM-SHOVEL CUT

that the diary is consulted less and less often as it increases in volume, and finally only in the most urgent cases.

That such a diary should be meager is only natural, for it is written by a man already wearied by a full day's work, and from whose memory items and details—important for record, though of only secondary current interest—have been temporarily obliterated by the more exciting occurrences or more exacting problems of the day.

Of course the time required to search such a diary would be reduced to a minimum by keeping it indexed day by day; but the time and effort required for such indexing are so great that it is seldom done. The very unsatisfactory results obtained from the old plan of keeping the diary caused the writer to devise a new scheme.

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The Field Diary is written in a loose-leaf book of a size (about 4½x7 in.) convenient for the pocket. Each leaf is devoted exclusively to a single structure or piece of work. For example, there is carried in the book, at any one time, a leaf for each cut, each culvert, each high

MILE 58 CART CUT 135* P. 2

DATE 1912	Time	Face at	Dumping at	Classification	Remarks
May 16	10 A	132+20	128+65	3'E. unif. over 2R.	No 1R.
	1R, 22L, 5 b, and 5L drilling ahead of face. Told foreman he is 0.2' below grade				
May 17	etc.	etc	etc	etc	etc

*Cut designated by the Five Station in the Cut

FIG. 2. TYPICAL OF ENTRIES IN FIELD DIARY FOR A CART CUT

way diversion, etc., which is in process of construction or to which attention is currently being given in the field.

Each leaf is headed with the mile, the local name and the designating station of the piece of work concerned. The leaves are arranged in the book in the order in which the corresponding pieces of work occur along the line, in the direction of mile or station numbering.

The leaves can be ruled to facilitate making the entries and, later, references thereto. This ruling can be done at odd times by those of the engineer corps who are least useful in the office. (See the rulings shown in Figs. 1, 2 and 3.)

The great majority of the entries in the Field Diary are made in the field. The engineer visits a piece of work in the field, and makes his inspection and observations there with the book in his hand. He records each

MILE 58 SMITH HIGHWAY 146 P. 2

DATE 1912	Time	
May 16	9 A	Temporary highway in bad condition on account of holes left by blasted stumps. Told foreman to fill holes at once. No work here since my previous visit.
May 17	8 A	2 L completing work of filling holes. Temp hwy now in good condition
etc	etc	etc

FIG. 3. TYPICAL OF ENTRIES IN FIELD DIARY FOR A HIGHWAY DIVISION

pertinent fact as soon as he observes or learns it, thus completing his Field Diary for that particular visit before he leaves the work.

The items of the following list are typical of those which should be recorded in the Field Diary at each visit to each piece of work:

1. Date, including hour of day.
2. If a cut—Station and plus of excavating and of dumping. Classification of excavation. Particulars regarding conduct of each part of work.
3. If a foundation excavation—Depth of excavation. Character of material excavated and being excavated. Place of dumping. Supporting power of underlying material. Particulars regarding conduct of each part of the work.
4. If a highway diversion or channel change—Station and plus of excavating and of dumping. Classification of material. Particulars regarding conduct of each part of work.
5. Forces and occupations—Force in sight; force out of sight (learned of foreman), force coming and when.
6. Plant—Plant in use and its condition and adequacy; plant on hand but idle, and its condition; plant coming and when.
7. Construction material—Kind and quality of material being used; kind, quality and quantity of material on hand, and how stored; materials coming and when.
8. Observations of engineer and statements of foreman (or other representative of contractor) in regard to the following: Progress of work, delays and their causes, accidents, labor troubles, floods, etc., since the preceding visit of engineer.
9. Contractor's plans for future.
10. Requests and complaints from foreman and others.
11. Verbal instructions to foreman and to inspector.
12. Written instructions; whether carbon copy is retained, which fact is merely noted in the Field Diary with a reference to the location of the retained copy. If carbon copy is not retained, a true copy of the written instructions is written in Field Diary.
13. Statements of the inspector.
14. Any other items that may have a current or future bearing on the work or on the relations between the two parties to the contract.

An entry made from hearsay should be so labeled and the source of the information noted. There are some kinds of information which are common to all work in progress and are best left for the Office Diary. For example, instead of entering the weather and temperature in the Field Diary at every piece of work visited

MAY ---- 1912.

Engineer Corps on May 1, 1912.

T. E. Munger ----- Div Eng ---------- Puckerbrush, Ind

Jone Residency ------ Jone, Ind.

J. F. Williams ---------- Res Eng
M. D. Blaze ---------- Instrumentman
A. L. Moses ---------- Rodman
Adam Ainsworth -------- Chainman
F. L. Jones ---------- Axeman

H. M. Balcomb ---------- Inspector
John Waterman -------- "
H. F. Meyer ---------- "

May 1, 1912 Mon. Noon temp 81° Thundershower 9 to 10 A. M.

etc etc. etc

FIG. 4. TYPICAL OF ENTRIES MADE IN OFFICE DIARY ON FIRST DAY OF EACH MONTH

during a day, it serves every purpose and saves time to enter them once for the day in the Office Diary.

Fig. 1 is typical of the entries made in the Field Diary on a visit to a steam-shovel cut. Attention is called to the rulings and column headings, which are always pertinent to a diary entry for steam-shovel work. By "p. 3" in the heading is meant that this is the third page of the Field Diary devoted to this particular cut.

As soon as an entire leaf is filled out (both sides), it is placed in a loose-leaf file in the office, and its place in the Field Diary is taken by a blank leaf with a similar heading. Field Diaries of resident engineer and instrumentman should have separate files in the office. In this office file of the Field Diary, all the leaves pertaining to one piece of work are placed together in the order of page numbers (that is, in chronological order), and the bunches of leaves thus formed are filed in the order in which the corresponding pieces of work occur along the line of the railway.

Noon temp. 73°. Fair all day

May 16, 1912, Wed.

Adam Ainsworth, chainman, was this afternoon transferred Terryville Res. His successor is John Beede who will begin work tomorrow morning.

Res. Eng. Williams walked east over line inspecting work at 460 cut, 476 fill, 51-A abutments, 490 highway, 500 cut, 510 fill, 520 cut, and 540 cut. Lunched at Brown's camp (sta. 510) where were Supt Flannagan and Mgr. White who said that foreman Tanner complained of having to wait for stakes. I told them that this foreman does not properly protect his stakes, and that as a rule he required three different settings of stakes for one arch excavation; and that he had never had to wait for the first setting, but sometimes for the second or third setting. I asked them to instruct Tanner to properly protect his stakes.

White said he thought the past month's estimate gave them too much earth in 520 cut. I told him that the classification was determined by the regular process, i. e. making the tests prescribed in the Specifications; and that I should be glad to have him or his representative present when determining the classification at the end of this month in the cut. — J. F. W.

Axeman Jones, with single rig from Briggs's stables, this morning drove to Miller Junction, got Edison cement samples from cars LB and Q 14,737 and LRN & 26,475, loaded and expressed these samples to Asst. Engr., lunched at the Junction House, and returned to office at 3.30 p. m. — F. L. J.

Instrumentman Blaze, with Moses and Ainsworth, carrying lunch, went west over line in Smith hack with driver, and spent the day on the following work:

Set line and grade on 220 fill.
Set lines for forms, sword stk near work west abutment 41-B.
Measured up stone box 42-B, which was completed yesterday.
Staked out highway diversion 265. — M. D. B.

May 17, 1912, Thurs. Noon temp. 77° Fair all day.
Instrumentman with entire party,
made situation survey for .....

FIG. 5. TYPICAL DAILY ENTRY IN OFFICE DIARY

Office Diary Kept by Whole Party

All items which should be recorded in a diary on construction and are not entered in the Field Diary are entered in the Office Diary, which may be kept in an ordinary bound blank book.

Each member of the resident engineering corps, who, during the day, has been separated from the others and in a position of some responsibility for the time, enters the items of his doings in the Office Diary and initials his entry. The entries need not be in any particular sequence for the different men. For example, if the rodman be the first to return to the office at the end of a day of detached duty, he may start the diary of the day by at once entering his own items.

On the first day of each month and preceding the entries for the work of the day, there are entered in the Office Diary the names of the members of the resident engineer corps, together with their positions, and the name, position and address of the engineer to whom the resident engineer reports. Fig. 4 is typical of the monthly entry of personnel.

The daily entries in the Office Diary should cover the following points:

1. Date.
2. Temperature and weather conditions during the day.